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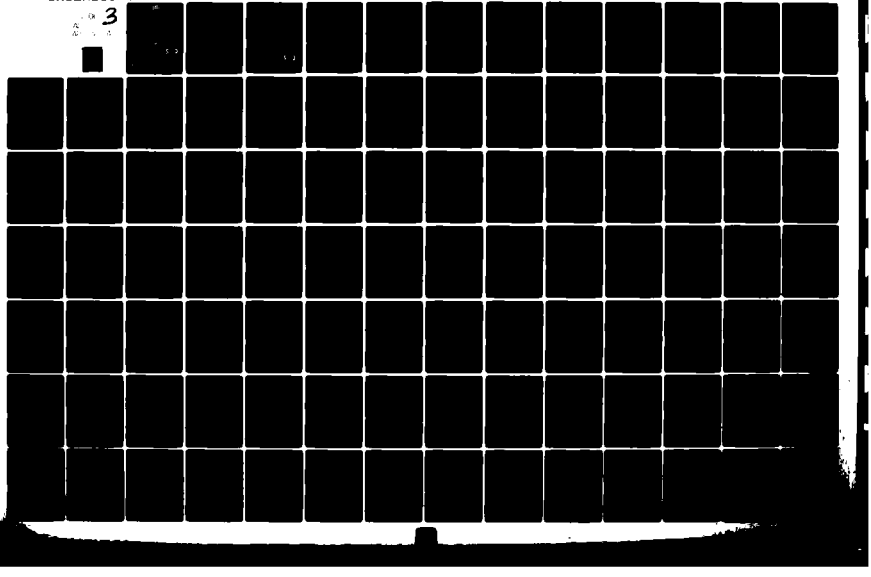

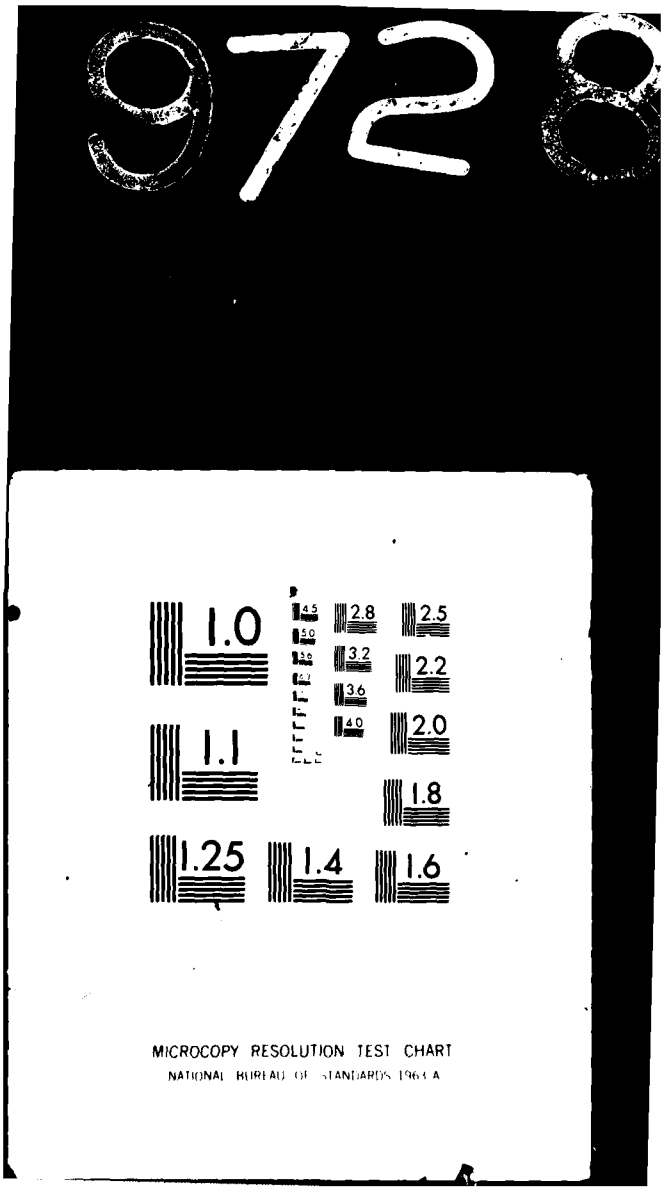
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Tidal Flows In Rivers And Harbors

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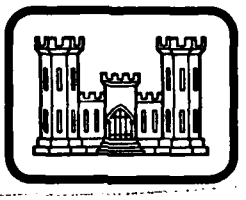

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PREFACE

Report No. 2, "Bibliography on Tidal Hydraulics," and Supplements No. 1, No. 2, No. 3, No. 4, No. 5, No. 6, and No. 7 thereto were published by the Committee on Tidal Hydraulics in 1954, 1955, 1957, 1959, 1965, 1968, 1971, and 1975, respectively, in connection with certain of its objectives. Additional references on the subject, either published since 1974 or not available at that time, have been accumulated for the present supplement. This supplement consists of approximately 540 references, all of which are available for loan, within the continental United States, from the Library Branch, U. S. Army Engineer Waterways Experiment Station (WES)

The supplement follows the same form as the original bibliography and consists of eight sections, each preceded by a brief statement of its scope. As a further convenience to the user, the references are arranged alphabetically under each subject-matter heading (section) and all have been annotated. Although the majority of the references appear in more than one section, the annotation appears only once -- under the most applicable subject heading -- with other listings of the reference omitting the annotation but including a key for its location.

Copies of this and other reports of the Committee may be obtained from the Committee on Tidal Hydraulics, care of U. S. Army Engineer Waterways Experiment Station (ATTN: WESTP), Corps of Engineers, P. O. Box 631, Vicksburg, Mississippi 39180.

This supplement was compiled by Virginia Dale and Alfrieda S. Clark, Special Projects Branch, Technical Information Center, WES.

Commanders and Directors of WES during the compilation and publication of this supplement were COL G. H. Hilt, CE, COL J. L. Cannon, CE, and COL N. P. Conover, CE. Technical Director was Mr. F. R. Brown.

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SECTION I. THEORETICAL CONSIDERATIONS

Basic principles of tidal hydraulics, including the mechanics and types of tides, height and time of tide, tide-producing forces, tidal currents, theories, cubature techniques, predictions, computations, estuarine circulation, and meteorological effects.

Abbott, M.B., Dahl-Madsen, K.I., Hinstrup, P.I., et al. River and Estuary Modeling with the Siva System. Symposium on Modeling Techniques, 2nd Annual Symposium of the Waterways, Harbors and Coastal Engineering Division of ASCE, San Francisco, California, September 3-5, 1975, vol.I, p.745-763. (See annotation in Section VI.)

Abood, K.A. Circulation in the Hudson Estuary. Hudson River Colloquium. Annals of the New York Academy of Sciences, vol.250, p.39-111, May 24, 1974.

Paper describes the hydrodynamic characteristics of partially stratified water bodies, as typified by the Hudson River, and presents a number of methods of establishing a quantitative relationship of density-induced velocity and circulation to salinity levels, freshwater runoff, and tidal characteristics. These methods utilize known or measurable physical and hydraulic parameters to determine the density-induced circulation (DIC) and mixing characteristics of estuaries. References (61 items).

Abood, K.A., and Bourodimos, E.L. Evaluation of Circulation in Estuaries. Journal of the Hydraulics Division, Proc. ASCE, vol.102, No.HY9, p.1211-1224, September 1976.

Several approaches describing density-induced circulation patterns in partially stratified estuaries have been developed. Published techniques developed by several investigators and recently established methods are used in this paper to convert Hudson River tidal velocities and salinity observations to density-induced flow rates. Generally, the two-layer stratified flow system approach exhibits several favorable characteristics such as relatively more stable and predictable distribution, greater independence of temporary meteorological and local eddy conditions, simplicity, ease, and availability of more precise detection instruments. Density-induced flow values obtained using the two-layer flow method are more realistic than their salt budget counterparts and are somewhat higher than those derived from tidal velocity observations. References (23 items).

Abraham, G., Karelse, M., and Lases, W.B.P.M. Data Requirement for One-Dimensional Mathematical Modelling of Salinity Intrusion in Estuaries. Delft Hydraulics Laboratory, Publication No.149, November 1975. Same in: Proceedings, XVIth Congress of the International Association for Hydraulic Research, São Paulo, Brazil, July 27 to August 1, 1975, vol.3, Paper C32. (See annotation in Section VI.)

Agalakov, S.S., Grigoriev, Yu. A., Gun'ko, F.G., et al. Laboratory Investigations into the Pattern of Currents in the Neva Estuary in the Gulf of Finland on Completion of Flood Defence Works for Leningrad. Proceedings, XVIth Congress of the International Association for Hydraulic Research, São Paulo, Brazil, July 27 to August 1, 1975, vol.1, Paper A22. (See annotation in Section VI.)

Ages, A.B. A Numerical Model of Victoria Harbour to Predict Tidal Response to Proposed Hydraulic Structures. Environment Canada, Marine Sciences Branch, Pacific Region, Pacific Marine Science Report No. 73-3, March 1973. (See annotation in Section VI.)

Ahr, W.M., Daubenspeck, J., Harry, H.W., et al. Resource Evaluation Studies on the Matagorda Bay Area, Texas. Texas A&M University, Sea Grant College, TAMU-SG-74-204, September 1973.

The water circulation patterns of Matagorda Bay were studied to determine the effect of water circulation on coastline change and pollution dispersal. The chronic pesticide and PCB levels in the bay sediments were estimated, and the physical-chemical variables governing the distribution and retention of chlorinated hydrocarbons in the sediments were investigated. Data on microfaunal populations, including information on the occurrences and distribution patterns of selected benthic microfauna, were examined in hopes of elucidating processes of coastal change, pollution and water circulation. The overall economic structure of the Matagorda Bay area was reviewed. Bibliography at end of each chapter.

Allen, G.P. Relationship Between Grain Size Parameter Distribution and Current Patterns in the Gironde Estuary (France). JOURNAL OF SEDIMENTARY PETROLOGY, vol.41, No.1, p.74-88, March 1971. (See annotation in Section II.)

Allen, G.P., Bonnefille, R., Courtois, G., et al. Processus de sédimentation des vases dans l'estuaire de la Gironde. Contribution d'un traceur radioactif pour l'étude du déplacement des vases (Sediment Drift and Accumulation Processes in the Gironde Estuary. Contribution of a Radioactive Tracer to the Study of Mud Displacement). LA HOUILLE BLANCHE,

vol.29, No.1/2, p.129-136, 1974. (In French.) (See annotation in Section II.)

Allen, G.P., Sauzay, G., Castaing, P., et al. Transport and Deposition of Suspended Sediment in the Gironde Estuary, France. Estuarine Processes; Volume II, Circulation, Sediments, and Transfer of Material in the Estuary, edited by Martin Wiley. New York, Academic Press, 1977, p.63-81. (See annotation in Section II.)

Amein, M. Computation of Flow Through Masonboro Inlet, N.C. Journal of the Waterways, Harbors and Coastal Engineering Division, Proc. ASCE, vol.101, No.WW 1, p.93-108, February 1975. Discussion, vol.102, No.WW1, p.105-106, February 1976; Closure, No.WW4, p.480, November 1976. (See annotation in Section VI.)

Amein, M., and Wardak, S.G. A Dynamic Water Quality Model for the Neuse Estuary, N.C. University of North Carolina, Sea Grant Program, Sea Grant Publication UNC-SG-75-28, December 1975. (See annotation in Section VI.)

Amin, M. Some Recent Investigations into the Harmonic Shallow Water Corrections Method of Tidal Predictions. INTERNATIONAL HYDROGRAPHIC REVIEW, Monaco, vol.54, No.1, p.87-108, January 1977.

To overcome the inadequacies of the harmonic method in the analysis and prediction of shallow water tidal regimes, DOODSON (1957) devised a Harmonic Shallow Water Corrections (H.S.W.C.) method to improve the quality of predicted times and heights of tidal turning points. This method proved to be very powerful where the constituent M_2 is relatively dominant in the tide. The theoretical background and the technique of application as presented by DOODSON are devised for hand calculations and for use on mechanical harmonic analog machines which were geared for conventional constituents, not H.S.W.C. constituents. In this paper the method is reformulated using a spectral analysis technique, thus providing a clear explanation of the fundamental ideas involved. In the spectrum of a finite time series record sampled at regular intervals, all the energy at frequencies above the Nyquist frequency is aliased with frequencies below the Nyquist frequency. The aliasing phenomenon when applied to high and low waters, occurring at intervals of approximately half a lunar day, has the inherent advantage that numerous constituents combine together, even eliminating the need for separate identification. Caution must be exercised, however, due to the fact that the time interval of half a lunar day is an approximation only. Any selected constituents can be resolved by use of the least squares method. This technique will be free from previous limitations of a fixed length data (355 days) requirement, and it will also handle effectively discontinuous data. An intensive comparison of Extended Harmonic Method (E.H.M.), Improved Response Method (I.R.M.) and H.S.W.C. method shows that all these methods are approaching their theoretical limits. Examination of residuals indicates that they are similar in accuracy, but for some typical requirements one method can compute predictions marginally better than the others. References (10 items).

Amos, C.L., and Collins, M.B. The Combined Effects of Wave Motion and Tidal Currents on the Morphology of Intertidal Ripple Marks: The Wash, U. K. JOURNAL OF SEDIMENTARY PETROLOGY, vol.48, No.3, p.849-856, September 1978. (See annotation in Section II.)

Anderson, F.E. The Effect of Boat Waves on the Sedimentary Processes of a New England Tidal Flat. University of New Hampshire, Department of Earth Sciences and Jackson Estuarine Laboratory, Durham, Technical Report, 1 February 1974. (See annotation in Section II.)

Anwar, H.O. Turbulent Dispersion and Meandering of a Surface Plume. Proceedings, XVIth Congress of the International Association for Hydraulic Research, São Paulo, Brazil, July 27 to August 1, 1975, vol.1, Paper A46.

Four series of field measurements were undertaken to determine the spread of marked fluid released in a near shore and an off shore region. The measurements were carried out when the tidal current was either decelerating or almost stationary. The outstanding result was that obtained when the tidal current was decelerating, the spread of the marked fluid then being greater than when the current was stationary. The axis of the self-induced plume, and its meandering, were determined from measured data. It was found that in the near shore region the axis of the plume lay parallel to the coast. The results of measurements revealed that the value of the turbulent eddy diffusivity was constant when the tidal current remained stationary. This value for the off shore region was much

smaller than that obtained for the near shore region. References (3 items).

Apelt, C.J., and Gout, J.J. Numerical Modelling of Tidal Phenomena in Bays and Estuaries with Intertidal Flats. Fifth Australasian Conference on Hydraulic and Fluid Mechanics, University of Canterbury, Christchurch, New Zealand, 9-13 December 1974; Conference Proceedings, vol.II, p.250-257. (See annotation in Section VI.)

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Ariathurai, C.R. A Finite Element Model for Sediment Transport in Estuaries. Dissertation, Ph.D. in Engineering, University of California at Davis, 1974. (See annotation in Section VI.)

Ariathurai, R., and Krone, R.B. Finite Element Model for Cohesive Sediment Transport. Journal of the Hydraulics Division, Proc. ASCE, vol.102, No.HY3, p.323-338, March 1976. (See annotation in Section VI.)

Ariathurai, R., and Krone, R.B. Mathematical Modeling of Sediment Transport in Estuaries. Estuarine Processes; Volume II, Circulation, Sediments, and Transfer of Material in the Estuary, edited by Martin Wiley. New York, Academic Press, 1977, p.98-106. (See annotation in Section VI.)

Audunson, T., Mathisen, J.P., Naeser, H., et al. Comparison Between Physical and Mathematical Modelling of a Tidal Fjord System in Northern Norway. Symposium on Modeling Techniques, 2nd Annual Symposium of the Waterways, Harbors and Coastal Engineering Division of ASCE, San Francisco, California, vol.II, September 3-5, 1975, p.1291-1310. (See annotation in Section VI.)

Aydin, F.N., and Ahlert, R.C. A New View of Dispersion in Well-Mixed Estuaries. ECOLOGICAL MODELLING, vol.5, No.4, p.301-326, November 1978. (See annotation in Section VI.)

Ball, D.J., and Cox, N.J. Hydrodynamic Drag Force on Groups of Flat Plates. Journal of the Waterway, Port, Coastal and Ocean Division, Proceedings, ASCE, vol.104, No.WW2, p.163-173, May 1978.

The hydrodynamic drag on a rectangular group of 50 flat plates, with steady incident flow normal to the front of the group, is shown to be a function of five factors: (1) The acceleration of flow between the plates of a row; (2) the shielding of plates in line with the incident flow; (3) the diversion of flow around the front of the group; (4) the rejection of flow through the sides of the group; and (5) the formation within the group of an oscillating wake for the whole group. The drag force on each element of the group was measured for longitudinal and lateral spacings covering the range occurring in existing pier head pile groups that the flat plates simulated. References (10 items).

Barailler, L., Cunge, J.A., and Montaz, J.P. Etudes sur modèles physiques et mathématiques de l'évolution des fonds due à la marée dans les estuaires; Application à l'estuaire de le Seine (Studies on Physical and Mathematical Models of the Evolution of the Beds of Estuaries - Applied to the Estuary of the Seine). Proceedings, XVIth Congress of the International Association for Hydraulic Research, São Paulo, Brazil, July 27 to August 1, 1975, vol.1, Paper A3. (In French.) (See annotation in Section VI.)

Barber, F.G., Murty, T.S., and Taylor, J.A. Preliminary Tidal Exchange Experiment in Masset Inlet. Marine Sciences Directorate, Department of the Environment, Ottawa, Canada, Manuscript Report Series No.39, 1975.

Concepts of exchange processes are reviewed briefly including a tidal exchange process believed to have been observed in a small tidal inlet in the arctic. The results of a numerical experiment with the latter process in a configuration similar to Masset Inlet are presented and a proposal concerning a field experiment is developed. References (32 items).

Bard, H., and Krutchkoff, R.G. A Stochastic Model for the James. Virginia Polytechnic Institute and State University, Blacksburg, Water Resources Research Center, August 1973. (See annotation in Section VI.)

Barrett, M.J., and Mollowney, B.M. Pollution Problems in Relation to the Thames Barrier. Philosophical Transactions of the Royal Society of London, Mathematical and Physical Sciences, vol.272, No.1221, p.213-221, May 4, 1972. (See annotation in Section VI.)

Barwis, J.H. Annotated Bibliography on the Geologic, Hydraulic, and Engineering Aspects of Tidal Inlets. U.S. Army Corps of Engineers, General Investigation of Tidal Inlets, GITI Report 4, January 1976. (See annotation in Section II.)

Barwis, J.H. Catalog of Tidal Inlet Aerial Photography. U.S. Army Corps of Engineers, General Investigation of Tidal Inlets, GITI Report 75-2, June 1975. (See annotation in Section VIII.)

Basu, A.N. Inclusion of Actual Bed Slope of a Tidal River in Hydrodynamical Model. In: Proceedings, Forty-Fourth Annual Research Session, Chandigarh, 29 January - 1 February 1975, Volume II - Hydraulics. Central Board of Irrigation and Power (India), Publication No.123, January 1975, p.128-133.

Inclusion of actual bed slope of a tidal river in the study of tidal propagation is very difficult. The present practice is to try with different slopes in the mathematical model and choose that one which gives closer reproduction of the prototype. In this communication a method has been presented to include the actual bed slope of a river in the flow equations. It has been concluded that the bed slope of a river is implicitly included in the equation of motion if a fixed datum is considered to measure vertical tide. This conclusion has been verified by means of an example. References (4 items).

Bellessort, B. Movement of Suspended Sediments in Estuaries: Flocculation and Rate of Removal of Muddy Sediments. Paper presented at a panel meeting on the Use of Tracers in Sedimentology, held at the Centre d'Etudes Nucleaires de Saclay, 21-25 June 1971. In: Tracer Techniques in Sediment Transport, International Atomic Energy Agency, Vienna, Technical Report Series No.145, p.31-40, May 1973. (See annotation in Section II.)

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Besnier, G., and Leroy, E. L'aménagement des estuaires de la Vilaine et du Lay (Development of the Vilaine and Lay Estuaries). LA HOUILLE BLANCHE, vol.29, No.1/2, p.91-102, 1974. (In French.) (See annotation in Section II.)

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Billen, G., and Smitz, J. Mathematical Model of Water Quality in a Highly Polluted Estuary. Hydrodynamics of Estuaries and Fjords; Proceedings of the 9th Liege Colloquium on Ocean Hydrodynamics, 1977, p.55-62. (See annotation in Section VI.)

Blair, C.H. Similitude of Mass Transfer Processes in Distorted Froude Model of an Estuary. Ph.D. Dissertation, Old Dominion University, Norfolk, Virginia, March 1976. (See annotation in Section VI.)

Blair, C.H., Cox, J.H., and Kuo, C.Y. Investigation of Flushing Time in the Lafayette River, Norfolk, Virginia. Department of Civil Engineering, School of Engineering, Old Dominion University, Norfolk, Virginia, Technical Report 76-C4, December 1976. (See annotation in Section VII.)

Blumberg, A.F. The Influence of Density Variations on Estuarine Tides and Circulations. ESTUARINE AND COASTAL MARINE SCIENCE, vol.6, No.2, p.209-215, February 1978.

Numerical experiments are carried out to investigate the influence of density variations on estuarine tides and circulations. The mathematical model, which has been previously published, is outlined. A detailed analysis of the tidal properties and circulations in an estuary is made for two cases. One case involved density variations while the other assumed a constant density. It was found that the discharge through any section, the tidal range, and the tidal phases were independent of the density structure. However, the actual tidal amplitudes, the mean elevation and the vertical structure of longitudinal velocity changed considerably in the various experiments. Both cases assumed the same coefficient of bottom friction and bathymetric schematization. References (5 items).

Blumberg, A.F. A Numerical Investigation into the Dynamics of Estuarine Circulation. Chesapeake Bay Institute, The Johns Hopkins University, Technical Report 91, Reference 75-9, October 1975.

A real time numerical model is developed to describe the dynamics and kinematics of partially mixed estuaries. The governing equations are formally laterally averaged and realistic estuarine bathymetry is included. The external inputs to the model are the salinity and tidal amplitude as a function of time at the ocean boundary and the freshwater discharge at the river boundary. The model includes the continuity, salt, and momentum balance equations coupled by an equation of state. The numerical technique conserves volume, salt, and momentum in the absence of dissipative effects. Simulations show that using a constant vertical eddy viscosity and diffusivity produce unrealistic salinity distributions, but have minor effects on the surface amplitudes. Results from the application of the model using a stability dependent eddy viscosity and diffusivity to the Potomac Estuary yield distributions comparable to field observations. Further numerical experimentation illustrates the response of the circulation to changes in the boundary friction and the river discharge. It is shown that the inclusion of horizontal mixing coefficients equal to 10^6 cm^2/sec yields totally unrealistic salinity distributions. The time variability in the magnitude of the various terms in the salt balance equation reveals that the dominant balance is between the longitudinal and vertical advective terms. The time dependent and turbulent flux terms become important prior to slack water. Also, the turbulent flux intensifies during the flood tide. Bibliography (52 items).

Blumberg, A.F. Numerical Model of Estuarine Circulation. Journal of the Hydraulics Division, Proc. ASCE, vol.103, No.HY3, p.295-310, March 1977. (See annotation in Section VI.)

Blumberg, A.F. Numerical Tidal Model of Chesapeake Bay. Journal of the Hydraulics Division, Proc. ASCE, vol.103, No.HY1, p.1-10, January 1977. (See annotation in Section VI.)

Blumberg, A.F. A Two-Dimensional Numerical Model for the Simulation of Partially Mixed Estuaries. Estuarine Processes; Volume II, Circulation, Sediments, and Transfer of Material in the Estuary, edited by Martin Wiley. New York, Academic Press, 1977, p.323-331. (See annotation in Section VI.)

Boericke, R.R., and Hogan, J.M. An X-Z Hydraulic/Thermal Model for Estuaries. Journal of the Hydraulics Division, Proc. ASCE, vol.103, No.HY1, p.19-37, January 1977. (See annotation in Section VI.)

Bokuniewicz, H.J. Estuarine Sediment Flux Evaluated in Long Island Sound. Ph.D. Dissertation, Yale University, May 1976. (See annotation in Section II.)

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Bonnefille, R. Residual Phenomena in Estuaries, Application to the Gironde Estuary. Hydrodynamics of Estuaries and Fjords; Proceedings of the 9th Liege Colloquium on Ocean Hydrodynamics, 1977, p.187-195. (See annotation in Section III.)

Bonnefille, R., Lepetit, J.P., and Lespine, E. Simulation des depôts de vase dans l'estuaire de la Gironde (Simulation of Silt Deposition in the Gironde Estuary). Proceedings, XVIth Congress of the International Association for Hydraulic Research, São Paulo, Brazil, July 27 to August 1, 1975, vol.1, Paper A24. (In French.) (See annotation in Section II.)

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Series, EPA-670/2-73-069, September 1973. (See annotation in Section V.)

Boothroyd, J.C., and Hubbard, D.K. Bed Form Development and Distribution Pattern, Parker and Essex Estuaries, Massachusetts. University of Massachusetts, Coastal Research Center, Miscellaneous Paper MP 1-74, February 1974. (See annotation in Section II.)

Bowden, K.F., and Hamilton, P. Some Experiments with a Numerical Model of Circulation and Mixing in a Tidal Estuary. ESTUARINE AND COASTAL MARINE SCIENCE, vol.3, No.3, p.281-301, July 1975. (See annotation in Section VI.)

Bowen, A.J., and Pinless, S.J. Effects of Bank Raising Along the Thames. Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, Copenhagen, Denmark, vol.III, 1975, Chapter 145 (p.2471-2482). (See annotation in Section VI.)

Bowen, A.J., and Pinless, S.J. The Response of an Estuary to the Closure of a Mobile Barrier; Richmond Barrier on the Upper Thames Estuary. ESTUARINE AND COASTAL MARINE SCIENCE, vol.5, No.2, p.197-208, March 1977. (See annotation in Section VI.)

Bowman, M.J. Spreading of the Hudson River Effluent into the New York Bight. Hydrodynamics of Estuaries and Fjords; Proceedings of the 9th Liege Colloquium on Ocean Hydrodynamics, 1977, p.373-386.

Results are presented from three Hudson River plume sampling cruises made in the New York Bight, in August 1976. The data show that the set and shape of the spreading effluent vary widely over time periods ~6 days, and are clearly influenced by local wind stress. Application of Takano's model of a steady state plume spreading into a stagnant ocean suggests a horizontal eddy viscosity ~10^8 cm^2 sec^{-1}, and a strong anticyclonic deflection of the plume. This value is considered to be an overestimate, since interfacial shear stress is neglected in the model. More careful measurements and calculations are needed to separate the effects of horizontal and vertical viscosities, Coriolis force, advection by a prevailing coastal current and local wind stress on plume dynamics. References (18 items).

Bowman, M.J. Tidal Locks Across the East River: An Engineering Solution to the Rehabilitation of Western Long Island Sound. In: Estuarine Processes; Volume I: Uses, Stresses, and Adaptation to the Estuary, edited by Martin Wiley. New York, San Francisco, London, Academic Press, 1976, p.28-43. (See annotation in Section IV).

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Bricker, O.P., III, and Troup, B.N. Sediment-Water Exchange in Chesapeake Bay. In: Estuarine Research, Volume I: Chemistry, Biology, and the Estuarine System, edited by L. Eugene Cronin, Academic Press, Inc., New York, 1975, p.3-27. (See annotation in Section II.)

Brooks, N.H. Dispersion in Hydrologic and Coastal Environments. W.M. Keck Laboratory of Hydraulics and Water Resources, California Institute of Technology, Report No.KH-R-29, December 1972. Same: U.S. Environmental Protection Agency, Pacific Northwest Environmental Research Laboratory, Report EPA 660/3-73-010, August 1973. 136p. (See annotation in Section IV.)

Bruun, P. Stability of Tidal Inlets; Theory and Engineering. New York, Elsevier, 1978. 506p. (See annotation in Section II.)

Bruun, P., Gerritsen, F., and Bhakta, N.P. Evaluation of Overall Entrance Stability of Tidal Entrances. Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, Copenhagen, Denmark, vol.II, 1975, Chapter 91 (p.1566-1584). (See annotation in Section II.)

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Burt, W.V., and Farreras, S.F. Predictive Nomograms of Hydraulic Conditions for the Siuslaw Estuary. SHORE & BEACH, vol.45, No.3, p 45-48, July 1977. (See annotation in Section VI.)

Cannon, G.A. Observations of Bottom-Water Flushing in a Fjord-Like Estuary. ESTUARINE AND COASTAL MARINE SCIENCE, vol.3, No.1, p.95-102, January 1975.

Currents were measured 2 m off the bottom on a 100-m-deep sill of a basin within Puget Sound for a period of two months. During this time bottom water in the basin was replaced resulting in the older water being raised to shallower depths. Net motion into the estuary occurred during four intervals each of about five days duration. In-flow corresponded with minimum variance in the velocity fluctuations and minimum tidal currents. Outflow occurred during maximum variance and tidal currents. The average speed during each of three of the five-day in-flow periods was about 6 cm/s and was approximately sufficient to replace all water below sill depth during the five days. References (7 items).

Cannon, G.A., and Laird, N.P. Variability of Currents and Water Properties from Year-Long Observations in a Fjord Estuary. Hydrodynamics of Estuaries and Fjords; Proceedings of the 9th Liege Colloquium on Ocean Hydrodynamics, 1977, p.515-535.

Observations were made of velocity, temperature, and conductivity from a vertical array of sensors at a location in Puget Sound for 1 year commencing in September 1975. Winds were measured nearby on land, and water properties were measured along the Sound at 2- to 3-month intervals. Most dense bottom water entered the Sound below sill depth at about fortnightly intervals during early fall near the end of the coastal upwelling season. The fortnightly events were associated with large tides over the entrance sill. Density decreased about linearly until early winter when cold water entered the Sound first at the bottom in a series of step decreases, also at about fortnightly intervals. The largest was 1.6°C in 3-4 days. Density increased during each inflow interval lasting about 5 days, but the overall density continued to decrease until early February when the water column became isothermal but was still stratified. During late winter and early spring, density again increased through a series of fortnightly salinity intrusions, and the initial one was more than 0.5°/oo in 5 days. Mean daily near-bottom speeds were up to about 20 cm/sec, implying a possible excursion exceeding the length of the Sound. Winds were observed to alter mean daily current profiles to more than half the water depth. These and other winter observations indicated deep-water renewal was much quicker than earlier estimates. References (16 items).

Caponi, E.A. The Simulation of Estuarine Circulations with a Fully Three-Dimensional Numerical Model. Estuarine Processes; Volume II, Circulation, Sediments, and Transfer of Material in the Estuary, edited by Martin Wiley. New York, Academic Press, 1977, p.332-346. (See annotation in Section VI.)

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Carter, H.H. The Distribution of Excess Temperature from the Morgantown Generating Station on the Potomac Estuary. Chesapeake Bay Institute, The Johns Hopkins University, Technical Report 84, Reference 73-10, October 1973. (See annotation in Section VIII.)

Carter, H.H. The Measurement of Rhodamine Tracers in Natural Systems by Fluorescence. Proceedings, Symposium, Physical Processes Responsible for Dispersal of Pollutants in the Sea, with Special Reference to the Near-Shore Zone, held in Arhus, Denmark, 4-7 July 1972, p.193-200. Copenhagen, Denmark, December 1974. (See annotation in Section VII.)

Carter, H.H. Simple One Dimensional Kinematic Model Results for the Bush River and Romney Creek. Chesapeake Bay Institute, The Johns Hopkins University, Special Report 49, Reference 76-2, March 1976. (See annotation in Section VI.)

Cartwright, D.E., and Young, C.M. Seiches and Tidal Ringing in the Sea near Shetland. Proceedings of the Royal Society of London, Series A, vol.338, p.111-128, 1974. (See annotation in Section VII.)

Study of medium-frequency waves from tide gauges and sea-bed pressure sensors around Shetland show a seiche of 50 cycles per day, confined to the east coast, and a curious enhancement of the 6th harmonic of the twice-daily tide, prominent

only near the edge of the continental shelf. Explanations of both are offered in terms of trapped edge-waves. References (13 items).

Cederwall, K., and Svensson, T. Sediment Flushing After Dredging in Tidal Bays. Journal of the Hydraulics Division, Proc. ASCE, vol.102, No.HY7, p.935-953, July 1976. (See annotation in Section VI.)

Celikkol, B., and Reichard, R. Hydrodynamic Model of the Great Bay Estuarine System. Part I. University of New Hampshire, Mechanics Research Laboratory, UNH Sea Grant Technical Report UNH-SG-153, August 1976. (See annotation in Section VI.)

Chadwick, N.R. The Barmby Tidal Barrage. Journal of the Institution of Water Engineers and Scientists, vol.29, No.7, p.317-335, October 1975. (See annotation in Section V.)

Chantler, A.G. The Applicability of Regime Theory to Tidal Watercourses. JOURNAL OF HYDRAULIC RESEARCH, vol.12, No.2, p.181-192, 1974.

Conclusions:

1. For tidal channels conventional regime relations alone are insufficient to describe the longitudinal variation of hydraulic geometry.
2. It is suggested that an end effect is responsible for channel enlargement beyond the widths required to convey the flow at each section.
3. Evidence has been presented to show that the mean velocity is constant at all sections along an estuary for a characteristic flow condition.
4. Tidal channel cross-sections undergo a natural "vertical exaggeration" in the landward direction.
5. The graphs of breadth to depth ratio against discharge for certain estuaries (four out of the six for which the appropriate data are available) are coincident provided that the values are referred to those at a characteristic central point for each estuary.
6. Tidal hydraulic geometry is a relatively unexplored field; the publication of further data would be of great value. References (16 items).

Chapra, S.C., and Nossa, G.A. Documentation for HARO3. A Computer Program for the Modeling of Water Quality Parameters in Steady State Multi-dimensional Natural Aquatic Systems. Second Edition. U.S. Environmental Protection Agency, New York, October 1974. (See annotation in Section IV.)

Charlton, J.A., McNicoll, W., and West, J.R. Tidal and Freshwater Induced Circulation in the Tay Estuary. The Royal Society of Edinburgh, Proceedings, Section B, vol.75, Parts 1/2, p.11-27, 1975.

An understanding of the movement of a body of water can be considered a prerequisite to any other study whether it be physical or biological. This is particularly so in the case of an estuary where the water movements are complex. The movement of water in an estuary is primarily governed by the tidal and freshwater inputs, the resulting flow being modified by bed and channel configurations, salinity, and silt-load variations. The tidal and freshwater inputs are themselves variables, the tidal range varying with the lunar cycle, and the freshwater input varying with the season or rainfall. The salinity variations within an estuary are interlinked with the tidal and freshwater fluctuating inputs. In addition the local and regional weather can modify the tidal response. The object of this paper is to consider the present state of knowledge of the resulting water circulation in the Tay estuary. Various authorities and workers have examined the estuary, and information gathered from their work will be presented as it forms a background to the work presently being carried out by a team from the Tay Estuary Research Centre. References (13 items).

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The Ria de Arosa, located on the Atlantic coast of northwest Spain (Galicia), is highly productive of mussels. The nutrients required to support this fishery apparently are supplied to the estuary by an inflow of oceanic water ($S \simeq 35.6^{o}/oo$) along the bottom while surface waters are being blown out to sea by northeasterly winds. Salinity, which has been observed (K.R. Tenore, personal communication) to correlate positively with the abundance of nutrients within the estuary, is used as a tracer. The salinities observed in two seasons at various locations in the estuary are shown to vary with the wind flow as indicated by weather maps and by an assessment of topographical influence. References (5 items).

Chatterjee, A.K. Numerical Model of a Tidal River. Bulletin of the Calcutta Mathematical Society, vol.64, No.4, p.151-157, December 1972. (See annotation in Section VI.)

Chatwin, P.C. Some Remarks on the Maintenance of the Salinity Distribution in Estuaries. ESTUARINE AND COASTAL MARINE SCIENCE, vol.4, No.5, p.555-556, September 1976. (See annotation in Section III.)

Chatwin, P.C., and Sullivan, P.J. How Some New Fundamental Results on Relative Turbulent Diffusion Can Be Relevant in Estuaries and Other Natural Flows. Hydrodynamics of Estuaries and Fjords; Proceedings of the 9th Liege Colloquium on Ocean Hydrodynamics, 1977, p.233-242. (See annotation in Section IV.)

Chen, C.W., Smith, D.J., Jackson, J.D., et al. Organic Sediment Model for Wastewater Outfall. Symposium on Modeling Techniques, 2nd Annual Symposium of the Waterways, Harbors and Coastal Engineering Division of ASCE, San Francisco, California, September 3-5, 1975, vol.I, p.179-207. (See annotation in Section VI.)

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Chevereau, G., Montaz, J.P., and Crouzet, Ph. Modèle mathematique de pollution par convection d'un traceur conservatif; Son utilisation dans l'etude de l'assainissement du Golfe du Morbihan. Proceedings, XVIth Congress of the International Association for Hydraulic Research, São Paulo, Brazil, July 27 to August 1, 1975, vol.4, Paper D21. (In French.) (See annotation in Section VI.)

Christensen, B.A., and Snyder, R.M. Physical Modeling of Scour Initiation and Sediment Transport in Distorted Tidal Models. Symposium on Modeling Techniques, 2nd Annual Symposium of the Waterways, Harbors and Coastal Engineering Division of ASCE, San Francisco, California, September 3-5, 1975, vol.II, p.927-935. (See annotation in Section VI.)

Christodoulou, G.C., and Connor, J.J. Numerical Modeling of Dispersion in Stratified Waters. Massachusetts Institute of Technology, Sea Grant Program, Report No. MITSG 76-17, November 20, 1976. (See annotation in Section VI.)

Christodoulou, G.C., Connor, J.J., and Pearce, B.R. Mathematical Modeling of Dispersion in Stratified Waters. Ralph M. Parsons Laboratory for Water Resources and Hydrodynamics, Department of Civil Engineering, Massachusetts Institute of Technology, Report No.219, October 1976. (See annotation in Section VI.)

Christodoulou, G.C., Connor, J.J., and Pearce, B.R. Mathematical Modeling of Dispersion in Stratified Waters. Massachusetts Institute of Technology, Department of Civil Engineering, Sea Grant Technical Report No. MITSG 76-14, November 1976. (See annotation in Section VI.)

Christodoulou, G.C., Leimkuhler, W.F., and Ippen, A.T. Mathematical Models of the Massachusetts Bay. Part III. A Mathematical Model for the Dispersion of Suspended Sediments in Coastal Waters. Ralph M. Parsons Laboratory for Water Resources and Hydrodynamics, Massachusetts Institute of Technology, Report No.179, January 1974. (See annotation in Section II.)

Christov, C., and Bayractarov, I. Propagation of Sea Wind Waves into the River Beds Estuaring into the Sea and Structures for Their Decreasing. Proceedings, XVIth Congress of the International Association for Hydraulic Research, São Paulo, Brazil, July 27 to August 1, 1975, vol.1, Paper A23. (See annotation in Section V.)

Codell, R.B. Digital Computer Simulation of Thermal Effluent Dispersion in Rivers, Lakes, and Estuaries. U.S. Army Missile Research, Development and Engineering Laboratory, Redstone Arsenal, Alabama, Technical Report RS-73-16, 5 November 1973. (See annotation in Section IV.)

Conomos, T.J. Movement of Spilled Oil as Predicted by Estuarine Nontidal Drift. LIMNOLOGY AND OCEANOGRAPHY, vol.20, No.2, p.159-173, March 1975. (See annotation in Section IV.)

Conomos, T.J., and Peterson, D.H. Suspended-Particle Transport and Circulation in San Francisco Bay: An Overview. Estuarine Processes, Volume II, Circulation, Sediments, and Transfer of Material in the Estuary, edited by Martin Wiley. New York, Academic Press, 1977, p.82-97. (See annotation in Section II.)

Costa, S.L., and Isaacs, J.D. Anisotropic Sand Transport in Tidal Inlets. Symposium on Modeling Techniques, 2nd Annual Symposium of the Waterways, Harbors and Coastal Engineering Division of ASCE, San Francisco, California, September 3-5, 1975, vol.I, p.254-273. (See annotation in Section VI.)

Covill, R.W. The Quality of the Forth Estuary. The Royal Society of Edinburgh, Proceedings, Section B, vol.71, Parts 2/4, p.143-170, 1972. (See annotation in Section IV.)

Craig, R.E. Water Movements in the Firth of Forth. The Royal Society of Edinburgh, Proceedings, Section B, vol.71, Parts 2/4, p.131-135, 1972.

Brief note on the importance of the Royal Society of Edinburgh in supporting research on the underlying principles of estuarine water conditions. References to Literature (18 items).

Crean, P.B. A Numerical Model of Baratropic Mixed Tides Between Vancouver Island and the Mainland and Its Relation to Studies of the Estuarine Circulation. Hydrodynamics of Estuaries and Fjords, Proceedings of the 9th Liege Colloquium on Ocean Hydrodynamics, 1977, p.283-313. (See annotation in Section III.)

Cronin, L.E., Pritchard, D.W., Koo, T.S.Y., et al. Effects of Enlargement of the Chesapeake and Delaware Canal. Estuarine Processes, Volume II, Circulation, Sediments, and Transfer of Material in the Estuary, edited by Martin Wiley. New York, Academic Press, 1977, p.18-32.

Recent enlargement of this artificial waterway has resulted in substantial alterations of the physical hydrography, chemical environment and biotic populations of the canal and its approaches. Net transport from the Chesapeake to the Delaware has been increased with enlarged tidal velocities and excursion, and the hydrographic pattern will remain complex. Salinity distribution has been slightly altered. The probability of transport of fish eggs and larvae into the Delaware is increased. The canal contains an abundant and diverse population of fish from freshwater, estuarine and marine sources and is used as a migration pathway by many species. Exceptionally dense concentrations of eggs and larvae of striped bass occur along with these stages of other species. Experimental observations on the effects of alterations in salinity and suspended sediment similar to those observed did not indicate detriment to eggs and larvae. Excessive transport to unfavorable water and minor damage from shear forces may be detrimental. Benthic populations are moderately abundant and no substantial damage to these has been observed. Because the results of environmental alterations are often subtle, and because uses of the canal are intensifying, continuing monitoring is strongly recommended. References (32 items).

Crookshank, N. Numerical Model Studies of Rivers and Estuaries. Proceedings of the First Canadian Hydraulics Conference, held at the University of Alberta, May 10 & 11, 1973, p.315-336. (See annotation in Section VI.)

Daiber, F.C. Flushing Pattern of Certain Tidal Streams in Delaware. Project Completion Report to Office of Water Resources Research, Department of the Interior, January 1972.

1. The flushing characteristics of two tidal streams, the Broadkill and Murderkill Rivers, have been established. a) Current velocities and volumes of water transport per tidal cycle have been calculated. b) Each stream can be divided into three segments along the longitudinal axis, a lower estuarine, upper estuarine and fresh water tidal. Each segment has its own salinity distribution, current velocities, tidal characteristics and flushing times. c) These two streams do not display the two-layer system at all times that is typical of coastal plain estuaries; having a net seaward transport at all depths. 2. Water quality characteristics of biological importance are described for the Broadkill River. a) There is a longitudinal and seasonal distribution of the various forms of phosphorus and nitrogen, oxygen, pH and chlorophyll pigments. b) The distribution of these various parameters is determined by the hydrographic features of the stream, the season and the location of one existing sewer outfall. References (2 items).

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2nd Annual Symposium of the Waterways, Harbors and Coastal Engineering Division of ASCE, San Francisco, California, September 3-5, 1975, vol.II, p.1535-1551. (See annotation in Section VI.)

Daniell, T.M. The Current Essentials of Dispersion and Diffusion. First Australian Conference on Coastal Engineering, Sydney, May 14-17, 1973; Engineering Dynamics of the Coastal Zone, p.151-158.

The terms diffusion and dispersion are discussed indicating their differences. The methods used to compute the dispersion coefficient D are analyzed demonstrating the various techniques used. The relationships between the different time scales for mixing are presented, indicating that the effects of transverse variations in velocity may cause D to be much greater than if only vertical velocity variations were considered. A review of some of the procedures which have been used for modeling dispersion in estuaries is given, showing the usefulness of the mixing terms. An extensive bibliography is included (44 items).

Daubert, A. La dispersion dans les ecoulements filaires (Filament Flow Dispersion). LA HOUILLE BLANCHE, vol.29, No.1/2, p.47-54, 1974. (In French.)

As shown by Taylor, the mechanism of longitudinal dispersion of effluent in a flowing liquid is basically related to the effect of lateral diffusion and differential convection (i.e. the difference between actual convection at a given point and average convection in a cross-section). Only these two types of exchange enter into the local dissolved matter balance equation, in addition to an average convection term. Inspectional analysis brings the effect of coefficient n into evidence, i.e. the time scale ratio between lateral diffusion and one-dimensional dispersion. At the same time, the dispersion coefficient is determined. By physical interpretation of the calculations, the respective parts played by lateral diffusion and differential convection in producing their overall longitudinal dispersion effect are established, thus confirming Taylor's assumptions.

Daubert, A., and Malherbe, J.F. Evaluation de la capacite de refrigeration d'un estuaire. Exemple de la Loire (Calculating the Cooling Capacity of an Estuary. Example of the Loire Estuary). LA HOUILLE BLANCHE, vol.29, No.1/2, p.35-46, 1974. (In French.)

Davidson, B. Process Control Model for Oxygen Regeneration of Polluted Rivers, Phase II. Water Resources Research Institute, Rutgers University, New Brunswick, N.J., April 1971. (See annotation in Section VI.)

Davidson, B. Process Control Model for Oxygen Regeneration of Polluted Rivers, Phases IV and V; and Spatially and Temporally Distributed Discharge of Effluents in Estuaries. Water Resources Research Institute, Rutgers University, New Brunswick, N.J., January 1974. (See annotation in Section VI.)

Davidson, B., and Hunter, J.V. Process Control Model for Oxygen Regeneration of Polluted Streams (Phase I). Water Resources Research Institute, Rutgers University, Brunswick, N.J., Research Project Technical Completion Report, March 1970. (See annotation in Section VI.)

Davidson, B., Vichnevetsky, R., and Wang, H.T. Numerical Techniques for Estimating Best Distributed Manning's Roughness Coefficients for Open Estuarial River Systems. WATER RESOURCES RESEARCH, vol.14, No.5, p.777-789, October 1978. (See annotation in Section VI.)

Day, J.W., Jr., Butler, T.J., and Conner, W.H. Productivity and Nutrient Export Studies in a Cypress Swamp and Lake System in Louisiana. Estuarine Processes; Volume II, Circulation, Sediments, and Transfer of Material in the Estuary, edited by Martin Wiley. New York, Academic Press, 1977, p.255-269.

During a 14-month period in 1973-74, several functional properties were studied in a swamp forest and lake system in Louisiana. The study area forms the upper drainage basin of the Barataria Bay estuary. Properties measured were: a) productivity of the two swamp forest components, bottomland hardwood (BLH) and baldcypress-tupelo (CT); b) productivity of lake and bayou waters; c) hydrology; and d) carbon and nutrient export to the lower estuary. Productivity of the BLH site was 800 g dry wt " m^{-2} yr^{-1} for stem biomass increase, 584 for litterfall, and 200 for understory production. Similar figures for CT were 500, 620, and 20. Total above-ground net productivity was 1584 for BLH and 1140 for CT. Net daytime photosynthesis (NDP) for the lake was 1418 g O_2 m^{-2} yr^{-1} and nighttime

respiration (NR) was 1868 (P/R = 0.76). For the bayous NDP was 316 and NR was 446 (P/R = 0.71). Water discharge from the basin is significant year-round except during the summer when evaporation equals precipitation. Annual export to the lower estuary (calculated from water discharge and materials concentrations) was 8016 metric tons of organic C, 1047 metric tons N, and 154 metric tons P. The greater part of this export occurred during the spring, corresponding to the spring peak in biological activity in the estuary. References (32 items).

Dazzi, R., and Tomasino, M. Mathematical Model of Salinity Intrusion in the Delta of the Po River. Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, Copenhagen, Denmark, vol.III, 1975, Chapter 134 (p.2302-2321) (See annotation in Section III.)

Dazzi, R., and Tomasino, M. Salt Wedge: Which Schemes? Proceedings, XVIth Congress of the International Association for Hydraulic Research, São Paulo, Brazil, July 27 to August 1, 1975, vol.3, Paper C34. (See annotation in Section III.)

DeGuida, R., Connor, J.J., and Pearce, B. Application of Estimation Theory to Design of Sampling Programs for Verification of Coastal Dispersion Predictions. Massachusetts Institute of Technology, Sea Grant Program, Report No. MITSG 76-16, November 20, 1976.

The analytical framework for applying Kalman-Bucy filtering to dispersion in a coastal water body is developed. Particular emphasis is placed on quantification of the model uncertainty due to model parameters, source loadings, and velocity fields. The formulation is discretized with the Finite Element Method, and a number of comparison studies are presented. References (15 items).

Dellow, D.J., and Sutherland, A.J. Velocity Distribution Measurements in Tidal Streams. Fifth Australasian Conference on Hydraulics and Fluid Mechanics, University of Canterbury, Christchurch, New Zealand, 9-13 December 1974; Conference Proceedings, vol.II, p.133-140.

Detailed velocity measurements, at two river sections, made throughout a tidal cycle are presented. One Section is in a straight reach of channel with a regular cross section, the other is on a bend with a strongly asymmetrical cross section. Continuous analog outputs obtained simultaneously from each of the nine current meters were sampled at least every ten minutes to give detailed velocity-time records. By performing experiments in two stages with different placement of meters information for fifteen positions in each Section was obtained. The flow patterns were found to differ markedly according to the direction of the acceleration vector and not the velocity vector as might have been expected. An index point at which the velocity bore a constant ratio to the mean velocity in the Section was found only in the symmetrical section. References (9 items).

DeWitt, P., and Daiber, F.C. The Hydrography of the Broadkill River Estuary, Delaware. CHESAPEAKE SCIENCE, vol.14, No.1, p.28-40, March 1973. (See annotation in Section VIII.)

Dick, T.M., and Marsalek, J. Interfacial Shear Stress in Density Wedges. Proceedings of the First Canadian Hydraulics Conference, held at the University of Alberta, May 10 & 11, 1973, p.176-191 (See annotation in Section III.)

Dorron, L.N., and Whitehurst, C.A. Channel Erosion in Southwestern Louisiana Canal. Journal of the Waterway, Port, Coastal and Ocean Division, Proceedings, ASCE, vol.104, No.WW2, p.201-213, May 1978. (See annotation in Section II.)

Drapeau, G., Harrison, W., Bien, W., et al. Oil Slick Fate in a Region of Strong Tidal Currents. Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, Copenhagen, Denmark, vol.III, 1975, Chapter 130 (p.2245-2259) (See annotation in Section IV.)

Dyer, K.R. The Salt Balance in Stratified Estuaries. ESTUARINE AND COASTAL MARINE SCIENCE, vol.2, p.273-281, July 1974. (See annotation in Section III.)

Ecker, R.M., and Hendricks, J.W. Factors Affecting the Distribution of Contaminants in an Estuary. In: Dredging: Environmental Effects & Technology; Proceedings of WODCON VII, San Francisco, California, July 10-12, 1976, p.69-84. (See annotation in Section IV.)

Edwards, A., and Edelsten, D.J. Deep Water Renewal of Loch Etive: A Three

Basin Scottish Fjord. ESTUARINE AND COASTAL MARINE SCIENCE, vol.5, No.5, p.575-595, September 1977.

Loch Etive is a fjord with three basins. Innermost bottom water stagnates for months or years, with slowly changing temperature and salinity, falling deep oxygen concentration and with a secondary pycnocline below sill depth. A bottom water renewal is described and shown to be caused by low freshwater runoff. The renewal is a series of overflows of sill water during spring flood tides. During overflow, dense fluid forms a turbulent plume whose observed behavior is similar to that expected from theory: an entrainment constant of 0.013 is found on a bottom slope of 6°. Observations of salinity in the sill region show that the flushing time there is 4 weeks and that this is the response time of the renewal mechanism to changes in runoff. A model of the nonlinear dependence of renewal upon runoff is made and used to hindcast during 1964-1975. The hindcast is verified and shows that renewal is aperiodic with a mean repetition time of 1-1/3 years. References (17 items)

Elliott, A.J. Methods for Determining the Concentrations and Sources of Pollutants in Estuaries. Chesapeake Bay Institute, The Johns Hopkins University, Special Report 50, Reference 76-3, April 1976. (See annotation in Section VI.)

Elliott, A.J. A Numerical Model of the Internal Circulation in a Branching Tidal Estuary. Chesapeake Bay Institute, The Johns Hopkins University, Special Report 54, Reference 76-7, June 1976. (See annotation in Section VI.)

Elliott, A.J. A Steady State Two-Layered Non-coupled Dynamic and Kinematic Estuarine Model with Application to the Potomac Estuary. Chesapeake Bay Institute, The Johns Hopkins University, Special Report 44, Reference 75-6, July 1975. (See annotation in Section VI.)

Elliott, A.J., and Hendrix, T.E. Intensive Observations of the Circulation in the Potomac Estuary. Chesapeake Bay Institute, The Johns Hopkins University, Special Report 55, Reference 76-8, July 1976. (See annotation in Section VIII.)

Elliott, A.J., and Wang, D.-P. The Effect of Meteorological Forcing on the Chesapeake Bay: The Coupling between an Estuarine System and Its Adjacent Coastal Waters. Hydrodynamics of Estuaries and Fjords; Proceedings of the 9th Liege Colloquium on Ocean Hydrodynamics, 1977, p.127-145.

Surface elevation and current meter records from the Potomac estuary are combined with elevation and wind stress data over the Chesapeake Bay to investigate the coupling between the Potomac, the Bay and the coastal ocean. The dominant sea level fluctuations in the Chesapeake Bay were found to be generated at the mouth of the Bay by the action of Ekman dynamics. Winds which blew parallel to the coast caused fluctuations in the mean sea level at the Bay mouth, these fluctuations then travelled northward up the Bay. Other fluctuations were due to an Ekman effect within the Bay itself and also due to longitudinal seiche motions. The oscillations within the Potomac were due, in part, to the local forcing but were also due to co-oscillation with the Bay. Low frequency sea level fluctuations within the Potomac were the result of the Ekman effects in the coastal water; these disturbances, which had originated at the mouth of the Bay, appeared to influence the entire estuarine system. The results suggest that future estuarine studies should include the coupling with the coastal ocean, both in modelling and in observational investigations. The important time scales for the non-tidal fluctuations extend at least to monthly and seasonal periods. Therefore long term (several months to several years) monitoring of the wind, sea level, density and currents is required before the forcing and response mechanisms will be fully understood. References (9 items)

Elliott, B.A., and Reid, R.O. Salinity Induced Horizontal Estuarine Circulation. Journal of the Waterways, Harbors and Coastal Engineering Division, Proc. ASCE, vol.102, No.WW4, p.425-442, November 1976.

A finite difference approximation to the equations of motion without the field acceleration terms, and the salt conservation equation with an isotropic diffusion coefficient, are used to model the circulation of a rectangular basin having the gross dimensional characteristics of a bar-built estuary. The recursion relations include the dynamic effects of horizontal salinity variations. Two cases are examined; in the first case the basin has a constant depth and in the second case the bottom slope varies linearly across the basin. The resulting patterns of circulation are qualitatively analyzed using a vorticity equation. The analysis indicates that the dynamic effects of horizontal salinity gradients

can be significant in controlling the circulation in localized sections of the basin. References (25 items).

El-Sabh, M.I. Transport and Currents in the Gulf of St. Lawrence. Bedford Institute of Oceanography, Dartmouth, Nova Scotia, Canada, Report Series BI-R-75-9, July 1975.

Using all available oceanographic data in the Gulf of St. Lawrence prior to 1970, the superiority of the averaged data over the individual cruises data for geostrophic calculations is illustrated. The present study shows how geostrophic currents that are adjusted to satisfy the condition of zero net average salt transport faithfully produce accurate estimates of fresh water discharge from the Gulf of St. Lawrence. Horizontal advective transport of salt is found to be more important than horizontal diffusive transport. Furthermore the application of the principle of the salt continuity reduces the importance of the method to choose a reference level for geostrophic calculations. The field of surface geostrophic circulation in the Gulf has been calculated. The main features of the flow patterns obtained agree with the results of synoptic observations. Both clockwise and anticlockwise gyres are found to be common and responsible, in part, for the existence of areas with maximum and minimum primary production. Bibliography (64 items).

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A pilot study in Knight Inlet, British Columbia, has yielded measurements of large amplitude, nonlinear internal waves in the strongly stratified surface layer. A train of several waves with amplitudes exceeding 10 meters and periods of a few minutes, passed the vessel on each flood tide. Observations with profiling and fixed depth instruments showed that the waves travelled in a strongly sheared flow. The results are interpreted using Benjamin's approximate model for nonlinear waves in deep fluids, suitably modified to allow for shear. This model then provides the basis for an examination of conditions leading to shear flow instability. A solution to the eigenvalue problem for exponential stratification and shear is used to examine the interaction of the waves with the background flow; critical amplitudes corresponding to conditions of marginal stability are found to be comparable to those observed in Knight Inlet. The waves are discussed in terms of their likely contribution to vertical exchange processes in fjords. References (19 items).

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A program of research conducted by U.S. Army Coastal Engineering Research Center, Fort Belvoir, Virginia, and U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Detailed quarterly studies at North Inlet, South Carolina, have shown variation in wave parameters, beach and inlet morphology, and tidal hydraulics which are related to seasonal climatic patterns. Wind magnitude and direction, occurrence of northeast storms, and brackish water influx from adjacent Winyah Bay are significant process variables. Over 800 unique visual wave observations indicate that annual resultant wave energy flux is directed to the south. However, an energy flux reversal due to ebb tidal delta morphology results in longshore transport of sediment toward the inlet, adding to swash bars, the channel-margin linear bars, and a northward recurving spit. An estimate of the volume of inlet-directed longshore sediment transport (3.5×10^5 cubic meters per year), based on observed energy fluxes, gives a value which is 83 percent of the annual longshore transport rate (4.3×10^5 cubic meters per year), based on 39 years of spit and shoal growth. Beach profiles at 11 locations show that erosion is primarily due to northeast storms and that the shoreline is transgressive. The southern channel-margin linear bar of the ebb tidal delta has increased in width and length during recovery from the February 1973 northeast storm. Reduction in the cross-sectional area of the inlet throat during the fall and winter months is related to sediment added to the northern channel-margin linear bar. The flood tidal delta is migrating westward under the influence of waves at high tide and is being dissected by ebb flow from a minor tidal creek. Hydrographic observations over complete spring, mean, and neap tidal cycles have been used to determine the volume of the tidal prism, examine current velocity distributions, and determine coefficients of friction and repletion. Prism volume varies from 7.43×10^6 to 25.52×10^6 cubic meters, depending on tidal phase and meteorological influences, with a mean of 14.96×10^6 cubic meters. Maximum tidal current velocities reach 120 centimeters per second and time-velocity asymmetry is present. Bibliography (17 items.)

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This brief review can hardly be expected to cover even a small part of the estuarine literature. Book-length collections are given by Ippen (1966), Lauff (1967), Ward & Espey (1971), Gameson (1973), and Dyer (1973). Instead, an updated account of what is understood concerning the causes of dispersion in estuaries is given. Studies of mixing carried out through 1964 were reviewed by Bowden (1967). Although mention is made of some of these works briefly for completeness, the emphasis is on the period 1967-1974. Also mentions current methods for predicting and modeling dispersion and how these are limited by still incomplete understanding of the dispersion process. Literature Cited (91 items).

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Near-surface current measurements from locations along the channel of the St. Lawrence Estuary between Trois Pistoles and Baie Comeau are examined for consistent evidence of internal tides. The harmonic constituents of the local tidal streams at each site were estimated by harmonic analysis of the records, and from these were subtracted estimates of the harmonic constituents of the local barotropic tidal streams (those due to surface tides alone). The residues are taken as estimates of the harmonic constituents of the local baroclinic tidal streams (those due to internal tides alone). The results indicate the presence of a progressive internal semidiurnal tide of the Poincare type and diurnal tide of the Kelvin type propagating seaward from the inland end of the Laurentian Channel. The character of the observed internal tide agrees well with that predicted by theory for the given stratification and topography. Possible practical significance of the internal tides in assisting mixing, creating ice pressure, and causing seasonal changes in tidal streams is discussed. References (5 items).

Forrester, W.D., and El-Sabh, M.I. Principle of Salt Continuity Applied to Estuarine Transport Calculations. Proceedings, Symposium, Physical Processes Responsible for Dispersal of Pollutants in the Sea, with Special Reference to the Near-Shore Zone; held in Arhus, Denmark, 4-7 July 1972, p.49-52. Copenhagen, Denmark, December 1974.

The paper demonstrates that meaningful geostrophic current fields can be calculated in the two major entrances to the Gulf of St. Lawrence provided that (i) a time-averaged density field is employed, and (ii) a velocity adjustment is made to enforce the condition of zero net salt transport through the sections. Close agreement between volume discharges determined from the geostrophic currents and from estimates of net run-off and precipitation attests to the accuracy of the geostrophic currents. Horizontal diffusion is found to be negligibly small in comparison with horizontal advection as a mechanism for the transport of salt. It is suggested that the geostrophic currents should be reliable enough to give accurate estimates for the transport of any material carried in the water, provided there are no extreme gradients in its distribution. References (4 items).

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Harmonic prediction of equally spaced tidal heights is worked out so that the terms not depending on frequency are separated from those depending on this parameter. The latter are quickly computed by using a recurrent expression, therefore a short time is required to find the heights. If prediction for several ports is desirable, the terms depending on the frequency are computed once and for all and the computer's time will be considerably reduced. Times and heights of high and low waters are promptly and accurately obtained by Newton sucessive interpolation. Tests have shown excellent results. The computer program permits us to use optionally modulation factors f and angles u depending on the longitudes of the moon's node perigee and also on those longitudes and on the local latitude (Godin's, 1972). The usual node factors and angles depending only on the longitudes of the moon's node is another option. No tables are stored in the machine. Bibliography (3 items).

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The lagoon Ebrie, in Ivory Coast, is formed of different bays and branches before communicating by an artificial canal with the Gulf of Guinea. The two principal lateral branches are quite different: the western channel forms a natural prolongation of the central channel while the eastern channel begins with a constriction. Observed at the eastern and western entrances of the lagoon, the circulation is statistically different, particularly in the upper layer and during ebb-tide. The eastern channel shows, at times, anomalies of residual velocity profiles which determine the relative asymmetry: there is often a seaward jet in the mid layer. The stronger residual anomalies are connected with sensible departures from the semi-diurnal period, involving the existence of beats between the tides and other subtidal frequencies. A decrease of Richardson number occurs during the anomalous profiles. The vertical mixing, its asymmetry and anomalies could be explained by a criterion for the maintenance of turbulence, depending on transient stages of river discharges and on the wind at the subtidal frequencies. References (5 items).

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From previous published data on replacement of deep water in Byfjord an obvious relation is found to exist between northerly winds along the west coast of Norway during summer and the volume of deep water being replaced. Northerly summer winds induce upwelling of denser water to shallower depths, which then can spill over the sill and intrude into the fjord basin. The magnitude of replacement appears to be independent of variations in freshwater discharge and climate. Recent observations of current and water properties reveal that the exchange flow across the sill is basically two-layered: a landward flow in the lower and a seaward flow in the upper layer, with the level of no-net motion located at mid-depth. Short period (2-7 days) variations in the long-shore wind component are well reflected in the exchange flow. Wind speed extremes are followed one to two days later by corresponding extremes in the exchange flow, indicating the approximate

response time for the upwelling process. In periods of sustained northerly winds along the coast the inflow attains a saturation speed of about 30 cm/s, which is slightly less than the critical speed obtained from the mean stratification by assuming an ideal two-layer flow across the sill. References (13 items).

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Numerical calculations of pure advection based on interpolating polynomials evaluated using both the dependent variable and its derivatives are shown to be highly accurate. In one dimension, explicit methods of fourth or higher order are possible using information at only two computational points; a formal error analysis of the fourth-order method is corroborated through demonstrative calculations. Comparisons with other methods demonstrate that the two-point fourth-order method is significantly more accurate than methods of fourth or higher order which use interpolations based on four or five computational points. Extension of the principle to advection-diffusion calculations in two dimensions demonstrates excellent accuracy. The two-point higher order principle is shown to have direct applicability to the calculation of two-dimensional advection and diffusion in tidal environments at a time scale of several tidal cycles. References (3 items).

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The validity of estimations of current velocity from the distribution of a property subject to diffusion and advection is discussed. The observed salinity distribution in the Irish Sea, observed values of the diffusion coefficient, and the results of a tidal numerical model are used to investigate the water circulation pattern. The results show a residual Northward transport through the center of the Irish Sea, with Southward flowing transports to the East and West of the main stream. References (15 items).

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A method of numerically deriving a steady state three-dimensional velocity field from defined boundary values is described. The field is continuous, and subject to certain constraints on the vorticity. It would appear to offer a suitable description of the stratified circulation in type 1 and type 2 estuaries. The results of this method in a two-dimensional case have been compared with the results of a simple two-dimensional dynamic model. A parameter θ has been derived that determines the degree of agreement between this "pseudo-potential" method and the dynamic model. Dynamic reasoning would indicate that θ should be a function of the Richardson number (defined in relation to the tidal shear) only, and as such would not yield suitable values for the use of the pseudo-potential method. However, from observation of actual tidally-averaged velocity profiles, it would appear that θ is a function of some other variables as well--probably the geometry of the estuary, and that in some cases (e.g. the James River) the value is

suitable for the application of the pseudo-potential method. Two points should be emphasized: (1) The pseudo-potential method has only been tested in one specific configuration and under one specific set of boundary conditions. Indications are that for this case it can yield satisfactory results. That is not to say that in other cases it will not--for instance, although the method may work for type 1 and type 2 estuaries, there is no reason to suppose that it would not work for type 3 and type 4 estuaries--such cases simply have not been considered here. (2) The specific test applied to the method--that of velocity field interpolation from a well stratified flow at the "seaward" end to a completely unstratified flow at the "landward" end--is a very drastic one. In most applications of the method, the external boundaries would be considerably "closer" together and the resultant internal velocity field more strongly dependent on the boundary conditions, rather than on the specific interpolation procedure used. The performance of any interpolation procedure is improved as the volume between the boundaries is decreased. References (8 items).

Hunter, J.R. A One-Dimensional Dynamic and Kinematic Numerical Model Suitable for Canals and Estuaries. Chesapeake Bay Institute, The Johns Hopkins University, Special Report 47, Reference 75-10, November 1975. (See annotation in Section VI.)

Hyer, P.V., and Ruzecki, E.P. Changes in Salinity Structure of the James, York and Rappahannock Estuaries Resulting from the Effects of Tropical Storm Agnes. In The Chesapeake Research Consortium, Inc., The Effects of Tropical Storm Agnes on the Chesapeake Bay Estuarine System, CRC Publication No.54, November 1976, p.66-80. (See annotation in Section III.)

Ianniello, J.P. Tidally Induced Residual Currents in Estuaries of Constant Breadth and Depth. JOURNAL OF MARINE RESEARCH, vol.35, No.4, p.755-786, November 1977.

Two-dimensional analytic solutions are derived, as a function of depth and longitudinal distance, for the Eulerian and Lagrangian residual currents induced in narrow tidal channels of constant breadth, depth and rectangular cross-section by the nonlinear interactions of the first order tides. The turbulence is represented by several different vertically variable eddy viscosity models chosen to bracket the range of likely vertical variation. Realistic viscosity profiles are selected by matching observed tidal velocity profiles and realistic values of tidal dissipation. The nonlinearly induced currents have magnitudes on the order of $\eta_o h_o^{-1} U_{IR}$ where η_o is a typical tidal amplitude, h_o is the channel depth, and U_{IR} is a typical magnitude of the tidal current; these currents will be important in some partially stratified and unstratified estuaries. References (26 items).

Iwasaki, T. Computer Aid for Optimum Design of Tsunami Waves. Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, Copenhagen, Denmark, vol.I, 1975, Chapter 37 (p.642-659).

The tsunami process of their generation and propagation to the near-coast offshore region is discussed. Purpose is to give optimum configurations of tsunami waves of large magnitude, which can be used as boundary conditions for the analysis of the dynamic process near the shore or around structures in coastal zone. They are obtained by numerical computations along the southern coast of the Hokkaido and the Sanriku Coast for various tsunami sources set on the continental shelf facing to the Japan Submarine Trench. Dispersive nature of the tsunamis seems to make the problem very complicated. However statistical results thus obtained can be accepted for the base of design of structures. References (10 items).

Jackson, H. W. Estuary Studies (161 3) (Training Manual). U.S. Environmental Protection Agency, Cincinnati, Ohio, September 1972. (See annotation in Section IV.)

Jacobs, M.L. Salinity and Sedimentation Study -- Cooper River Rediversion, Charleston, South Carolina. WATER RESOURCES BULLETIN, vol.8, No.1, p.87-92, February 1972. (See annotation in Section III.)

Jamart, B.M., and Winter, D.F. A New Approach to the Computation of Tidal Motions in Estuaries. Hydrodynamics of Estuaries and Fjords; Proceeding of the 9th Liege Colloquium on Ocean Hydrodynamics, 1977, p.261-281. (See annotation in Section VI.)

James, A. Pollution of the River Tyne Estuary -- The Use of Mathematical

Models. WATER POLLUTION CONTROL, vol.75, No.3, p.322-340, 1976. (See annotation in Section VI.)

Jarrett, J.T. Tidal Prism - Inlet Area Relationships. U.S. Army Corps of Engineers, General Investigation of Tidal Inlets, GITI Report 3, February 1976.

A program of research conducted jointly by U.S. Army Coastal Engineering Research Center, Fort Belvoir, Virginia, and U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. The tidal prism - inlet area relationships for inlets on sandy coast established by M.P. O'Brien were reanalyzed using his data and data published by other investigators. In addition, tidal prism and inlet cross-sectional area data developed in the inlet Classification Study, a subfeature of the Corps of Engineers General Investigation of Tidal Inlets, were also used. These data result in a total of 162 data points for 108 inlets--59 of which are located on the Atlantic coast, 24 on the Gulf coast, and 25 on the Pacific coast of the United States. The data are grouped into three main categories, namely: (1) all inlets, (2) unjettied and single-jettied inlets, and (3) inlets with two jetties. Within each of these three categories, the data are further subdivided into: (a) inlets on all three coasts, (b) inlets on the Atlantic coast, (c) inlets on the Gulf coast, and (d) inlets on the Pacific coast. Regression analysis was performed on each set of data to determine the equations of best fit and to establish 95 percent confidence limits for the equations and the constants in the equations. The results of the regression analysis, which in all cases yielded an equation of the form $A = CP^n$, in which C and n are constants determined by the regression analysis, indicate that the tidal prism - inlet area relationship is not a unique function for all inlets but varies depending on inlet location and whether or not the inlet has been stabilized with a dual jetty system. References (20 items).

Johanson, P.A., Lorensen, M.W., and Waddell, W.W. A Multi-Parameter Estuary Model. Proceedings of the Conference on Environmental Modeling and Simulation, April 19-22, 1976, Cincinnati, Ohio, p.111-114. U.S. Environmental Protection Agency, EPA 600/9-76-016, July 1976. (See annotation in Section VI.)

Johnson, F.A. A Reconnaissance of the Hydrology of the Edisto and Ashepoo Estuaries, South Carolina. South Carolina Water Resources Commission, Report No.6, 1977. (See annotation in Section III.)

Johnson, R.W. A Simulation Model for Studying Effects of Pollution and Freshwater Inflow on Secondary Productivity in an Ecosystem. Ph.D. Thesis, Department of Marine Sciences, North Carolina State University at Raleigh, 1974. (See annotation in Section VI.)

Josefsson, B., and Nyquist, G. Fluorescence Tracing of the Flow and Disperson of Sulfite Wastes in a Fjord System. AMBIO, vol.5, No.4, p.183-187, 1976. (See annotation in Section IV.)

Kamphuis, J.W., and Mohammed, N. Runup of Irregular Waves on Plane Smooth Slope. Journal of the Waterway, Port, Coastal and Ocean Division, Proceedings, ASCE, vol.104, No.WW2, p.135-146, May 1978.

Runup of irregular waves on smooth slopes of 1:3, 1:2, 1:1-1/2, and 1:1 was investigated. The waves were generated by superposition of component waves and simulated the spectra by Bretschneider and Scott. A few narrow frequency band spectra were also generated. Since the waves were nonbreaking for the most part, the reflection process affected the results and thus was investigated in detail. Subsequently runup distributions were related to wave height distributions with special emphasis on average runup and 2% runup. A number of secondary observations with respect to superelevation of mean water level, spectrum bandwidth, runup period and position of the leading edge of the runup were also made. References (15 items).

Kashiwamura, M., and Yoshida, S. Flow Pattern at a River Mouth. International Symposium on Stratified Flows, Novosibirsk (U.S.S.R.), 1972, Communication 14.

Symposium sponsored by the International Association for Hydraulic Research and the Academy of Sciences of the U.S.S.R. When the surface velocity is measured in the vicinity of a river mouth, large values in velocity are sometimes found at some unexpected places on the sea. This can be understood, by the following reasons, as a phenomenon brought by a property of the density current. As already published, the surface flow at a river mouth usually has various kinds of flow patterns, in response to a degree of the river discharge. It was newly revealed, in any pattern, that the surface velocity on the midstream accelerates itself

transiently, outside the mouth, due to the effect of buoyancy caused by the density difference of the fresh water and the sea water. In addition, another type of acceleration was also found at both corners of the mouth. Thus the distribution of the surface velocity appears to be complicated with such two types of acceleration. References (2 items).

Keen, K. A Survey of Dispersion Coefficients for Estimating Pollutant Transport. Grumman Aerospace Corporation, Grumman Research Department Memorandum RM-562, December 1972. (See annotation in Section IV.)

Kérisel, T. Aménagement de l'estuaire de la Seine. Approfondissement du chenal d'acce au port de Rouèn (Development of the Seine Estuary. Increasing the Depth of the Shipping Channel to the Port of Rouen). LA HOUILLE BLANCHE, vol.29, No.1/2, p.55-66, 1974. (In French.) (See annotation in Section VI.)

King, D.B., Jr. The Dynamics of Inlets and Bays. Coastal and Oceanographic Engineering Laboratory, Technical Report No.22, March 1974. (See annotation in Section VI.)

King, D.B., and Shemdin, O.H. Modeling of Inlet-Bay Systems in Relation to Sand Trapping. Symposium on Modeling Techniques, 2nd Annual Symposium of the Waterways, Harbors and Coastal Engineering Division of ASCE, San Francisco, California, September 3-5, 1975, vol.II, p.1623-1637. (See annotation in Section VI.)

Kjelson, M.A., and Colby, D.R. The Evaluation and Use of Gear Efficiencies in the Estimation of Estuarine Fish Abundance. Estuarine Processes; Volume II, Circulation, Sediments, and Transfer of Material in the Estuary, edited by Martin Wiley. New York, Academic Press, 1977, p.416-424.

Accurate estimates of fish abundance are necessary for models of many estuarine processes, but they have generally been unavailable because fish sampling methods are biased. A major source of bias is a fish's avoidance of sampling gear. A brief discussion of theoretical and qualitative information concerning net avoidance and a simple gear efficiency model is presented. Results of quantitative studies on the efficiency of sampling gear have potential for correcting bias due to net avoidance. Discussion of gear efficiency studies for a plankton net, beam trawls, portable drop-net, haul seines and otter trawls are provided and indicate that such research is feasible and can yield useful information. Our ongoing investigation on the efficiency of a 6.1 m otter trawl for Lagodon rhomboides and Leiostomus xanthurus in a North Carolina estuary during 1975 indicates that trawl abundance estimates for these species were only 9 to 51% of the true values. General recommendations are given to assist in limiting the problem of fish sampling bias. Literature Cited (16 items).

Kjerfve, B. Velocity Averaging in Estuaries Characterized by a Large Tidal Range to Depth Ratio. ESTUARINE AND COASTAL MARINE SCIENCE, vol.3, No.3, p.311-323, July 1975.

A general procedure to compute net velocity profiles is proposed for estuaries with a large ratio, ε, of tidal range to mean water depth. Such a technique is desirable in view of the continued interest and numerous and varied research efforts in shallow estuarine waters where flow information is essential. Because ε exceeds 0.3 in many coastal plain and bar-built estuaries, problems arise in the computation of time-averaged velocity profiles. However, by non-dimensionalization of the depth before time-averaging, these problems are avoided. Rational procedures for the calculation of flow discharge and flux of dissolved and suspended constituents are also proposed for estuaries with a large ε-ratio. The averaging procedures are illustrated by computations on 561 velocity profiles measured in the Duplin River, a Georgia (U.S.A.) coastal plain estuary with $\varepsilon = 0.5$. References (17 items).

Klemas, V. Remote Sensing of Coastal Pollutants. Delaware University, College of Marine Studies, 1978. National Aeronautics and Space Administration, CR-157586. (See annotation in Section VII.)

Klemas, V. Remote Sensing of Coastal Wetland Vegetation and Estuarine Water Properties. Estuarine Processes; Volume II, Circulation, Sediments, and Transfer of Material in the Estuary, edited by Martin Wiley. New York, Academic Press, 1977, p.381-403. (See annotation in Section VII.)

Klemas, V., and Polis, D.F. Remote Sensing of Estuarine Fronts and Their Effects

on Pollutants. PHOTOGRAMMETRIC ENGINEERING AND REMOTE SENSING, vol.43, No.5, p.599-612, May 1977. (See annotation in Section VII.)

Klemas, V., and Polis, D.F. A Study of Density Fronts and Their Effects on Coastal Pollutants. REMOTE SENSING OF ENVIRONMENT, vol.6, No.2, p.95-126, 1977. (See annotation in Section VII.)

Klemas, V., Bartlett, D., Philpot, W., et al. Coastal and Estuarine Studies with ERTS-1 and Skylab. REMOTE SENSING OF ENVIRONMENT, vol.3, No.3, p.153-174, 1974. (See annotation in Section VII.)

Klemas, V., Davis, G., and Wang, H. A Cost-Effective Satellite-Aircraft-Drogue Approach for Studying Estuarine Circulation and Shelf Waste Dispersion. Ocean 75 Record: 1975 IEEE Conference on Engineering in the Ocean Environment, and Eleventh Annual Meeting of the Marine Technology Society, San Diego, California, September 22-25, 1975, p.751-760. (See annotation in Section VII.)

Klemas, V., Davis, G., and Wang, H. Monitoring Estuarine Circulation and Ocean Waste Dispersion Using an Integrated Satellite-Aircraft-Drogue Approach. Proceedings of the International Conference on Environmental Sensing and Assessment, Las Vegas, Nevada, September 14-19, 1975, vol.I. (See annotation in Section VII.)

Klemas, V., Davis, G., and Wang, H. Monitoring Estuarine Circulation and Ocean Waste Dispersion Using an Integrated Satellite-Aircraft-Drogue Approach. University of Delaware, College of Marine Studies, October 30, 1975. (See annotation in Section VII.)

Klemas, V., Otley, M., Wethe, C., et al. Monitoring Coastal Water Properties and Current Circulation with Spacecraft. Second Joint Conference on Sensing of Environmental Pollutants, Washington, D.C., December 10-12, 1973, p.343-354. (See annotation in Section VII.)

Knebel, H.J., Conomos, T.J., and Commeau, J.A. Clay-Mineral Variability in the Suspended Sediments of the San Francisco Bay System, California. JOURNAL OF SEDIMENTARY PETROLOGY, vol.47, No.1, p.229-236, March 1977. (See annotation in Section II.)

Knowles, C.E. Flow Dynamics of the Neuse River Estuary, North Carolina, for the Period 7 August to 14 September 1973. University of North Carolina Sea Grant Program Publication UNC-SG-75-16, August 1975.

A 38-day definitive study of the Neuse River circulation was undertaken from 7 August to 14 September 1973. From this study the following conclusions can be made: (1) The net circulation in the river is slow and complicated (has circular flow patterns across river and return flow up-stream). A rough estimate of the mean net flow for the river is 1.81 cm/sec and the corresponding transit time for water starting near New Bern and entering Pamlico Sound is 32 days. Because of the complicated cross-stream, up-stream flow waste materials could remain in a local area for a time considerably longer than that predicted by the rough transit time included above. (2) Lunar tides may be the driving mechanism for the observed circulation at all stations up-stream from Pamlico Sound. All these stations have a near tidal period in the up-stream, down-stream current fluctuations. (3) The winds tend to, but no not always enhance the river circulation. References (7 items).

Knowles, C.E., and Singer, J.J. Exchange Through a Barrier Island Inlet: Additional Evidence of Upwelling Off the Northeast Coast of North Carolina. JOURNAL OF PHYSICAL OCEANOGRAPHY, vol.7, No.1, p.146-152, January 1977. (See annotation in Section VIII.)

Kramer, G.R. Predicting Reaeration Coefficients for Polluted Estuary. Journal of the Environmental Engineering Division, Proc. ASCE, vol.100, No.EE1, p.77-92, February 1974.

The objective of this study was to determine if reaeration rate coefficients in polluted estuaries could be predicted from equations that predict these coefficients in natural streams. Many of the currently available equations relating K_2 with the physical and hydrodynamic characteristics of the waterway were listed along with some of the conditions under which they were derived or determined. A review of the effects of wind, temperature, and surface active agents on reaeration was presented. A number of the given equations were applied to the Houston Ship Channel in an attempt to predict K_2. It was found that the predicted K_2 was usually less than 1/100

of the measured K_2 as determined in preliminary measurements. It was concluded that none of these equations are applicable to the upper Houston Ship Channel area. References (52 items).

Krishnamurthy, M. Tidal Prism of Equilibrium Inlets. Journal of the Waterway, Port, Coastal and Ocean Division, Proc. ASCE, vol.103, No.WW4, p.423-432, November 1977.

Tidal prism is defined as the volume of water discharged through an inlet from ebb to flood tide. The magnitude of tidal prism depends on the cross-sectional area of the inlet. When an inlet is in equilibrium, many investigators have established a relationship between the two parameters. In this paper, a formula has been derived to estimate the value of tidal prism of an equilibrium inlet taking the range and period of the ocean tide, flow resistance of the channel, and the size of the bed material of the inlet into consideration. This formula has been compared with the available formulas and verified using data of existing equilibrium inlets. References (10 items).

Krone, R.B., and Ariathurai, R. Application of Predictive Sediment Transport Models. In: Dredging: Environmental Effects & Technology; Proceedings of WODCON VII, San Francisco, California, July 10-12, 1976, p.259-272. (See annotation in Section VI.)

Kuhn, G.D., and Nielsen, J.N. Application of Boundary-Layer Theory to Dispersion in Well-Mixed Estuaries. Nielsen Engineering & Research, Inc., NEAR TR 63, September 1974.

An analytical formula representing the law of the wall and the law of the wake of turbulent boundary-layer theory was found to represent the vertical velocity profiles of both laboratory channels and field data from real estuaries. The formula is used in an integral boundary layer calculation method to calculate the detailed time dependent flow field of two dimensional estuaries. For given tidal information, only the integrated continuity and momentum equations are necessary to calculate the two parameters of the formula. An analytical expression for the concentration profile is derived based on an analogy between turbulent exchange of momentum and mass. Good comparisons between theory and experiment were obtained for the flow field of a laboratory flume. References (17 items).

Kullenberg, G. Entrainment Velocity in Natural Stratified Vertical Shear Flow. ESTUARINE AND COASTAL MARINE SCIENCE, vol.5, No.3, p.329-338, May 1977.

The entrainment velocity is determined from mixing experiments in coastal waters with a well-mixed upper layer separated from a lower layer by a well-defined pycnocline. The experiments were carried out during conditions of strong winds. The dependence of the entrainment velocity upon the wind velocity and the density jump across the pycnocline is found to conform with reported results obtained by means of shear flow laboratory experiments. The essential parameter is an overall type Richardson number. On the other hand the ratio of the vertical transfer coefficients for mass and momentum is found to depend upon the local Richardson number. The change of potential energy due to the entrainment is related to the energy input from the wind. This leads to an estimate of the critical flux Richardson number which conforms with reported results. References (15 items).

Kuo, A.Y. A Model of Tidal Flushing for Small Coastal Basins. Proceedings of the Conference on Environmental Modeling and Simulation, April 19-22, 1976, p.543-547. U.S. Environmental Protection Agency, EPA 600/9-76-016, July 1976. (See annotation in Section VI.)

Kuo, A.Y., Nichols, M., and Lewis, J. Modeling Sediment Movement in the Turbidity Maximum of an Estuary. Virginia Polytechnic Institute and State University, Blacksburg, Virginia Water Resources Research Center, Bulletin No.111, June 1978. (See annotation in Section VI.)

Kuo, A.Y., Ruzecki, E.P., and Fang, C.S. The Effects of the Agnes Flood on the Salinity Structure of the Lower Chesapeake Bay and Contiguous Waters. In The Chesapeake Research Consortium, Inc., The Effects of Tropical Storm Agnes on the Chesapeake Bay Estuarine System, CRC Publication No. 54, November 1976, p.81-103. (See annotation in Section III.)

Kuo, C.Y. Effects of Salinity on Turbulent Diffusion of Pollutants. Water Resources Research Institute, Research Center, University of Puerto Rico, Mayaguez, UPRICO-WRRI-PR-73-74, December 1973. (See annotation in Section IV.)

Kuur, P. van der, and Verboom, G.K. Computational Analysis for Optimal Boundary Control of Two-Dimensional Tidal Model. Proceedings, XVIth Congress of the International Association for Hydraulic Research, São Paulo, Brazil, July 27 to August 1, 1975, vol.1, Paper A38. (See annotation in Section VI.)

Laevastu, T., Callaway, R., Stroud, A., et al. Computation of Tides, Currents, and Dispersal of Pollutants in the New York Bight from Block Island to Atlantic City with Large Grid Size, Single and Two-Layer Hydrodynamical-Numerical Models. Part 4. Environmental Prediction Research Facility (Navy), Monterey, California, Technical Note No.4-74, January 1974. (See annotation in Section VI.)

Laevastu, T., Clancy, M., and Stroud, A. Computation of Tides, Currents and Dispersal of Pollutants in Lower Bay and Approaches to New York with Fine Medium Grid Size Hydrodynamical-Numerical Models. Part 3. Environmental Prediction Research Facility (Navy), Monterey, California, Technical Note No.3-74, January 1974. (See annotation in Section VI.)

Lai, C., and Onions, C.A. Computation of Unsteady Flows in Rivers and Estuaries by the Method of Characteristics. U.S. Geological Survey, Report No.USGS/WRD/CC-76/034, June 1976. (See annotation in Section VI.)

Lambert, W.P., and Fruh, E.G. Methodology to Evaluate Alternative Coastal Zone Management Policies: Application in the Texas Coastal Zone. Special Report III: A Methodology for Investigating Fresh Water Inflow Requirements of a Texas Estuary; Volume I--Methodology. University of Texas at Austin, Center for Research in Water Resources, Environmental Health Engineering Research Laboratory, Technical Report EHE-76-01, CRWR-133, no date.

The study addressed the water resource management problem of determining fresh water inflow requirements for a Texas estuary. A computer-oriented methodology was developed for assessing those requirements. The methodology provided a general, rational approach to the inflow problem without being dependent upon specific machines and computer programs. Viability of the methodology was demonstrated using existing computer models within an estuarine management scenario developed for Corpus Christi Bay, Texas. The methodology has a two-step structure. STEP 1 translates qualitative, ecologically-oriented management policy goals for an estuary into a set of net fresh water inflow requirements. STEP 2 produces the set of upstream fresh water release schedules required to satisfy those net inflow requirements. References.

Lambert, W.P., and Fruh, E.G. Methodology to Evaluate Alternative Coastal Zone Management Policies: Application in the Texas Coastal Zone. Special Report III: A Methodology for Investigating Fresh Water Inflow Requirements of a Texas Estuary; Volume II--Appendices. University of Texas at Austin, Environmental Health Engineering Research Laboratory, Center for Research in Water Resources, no date.

The study addresses the water resource management problem of determining fresh water inflow requirements for a Texas estuary. A computer-oriented methodology, a two-step procedure, provides a general, rational approach to the inflow problem without being dependent upon specific machines and computer programs. Viability of the methodology is demonstrated by the use of existing computer models within an estuarine management scenario developed for Corpus Christi Bay, Texas. This volume contains the five appendices to this report: Area study; calibration, verification, and sensitivity analysis of HYDTID and LOTRAN; Computer programs; selected computational procedures; a compendium of experimental results generated during execution of the illustrative application of the investigative fresh water methodology. An extensive bibliography is included.

Lankford, R.R. Coastal Lagoons of Mexico; Their Origin and Classification. Estuarine Processes; Volume II, Circulation, Sediments, and Transfer of Material in the Estuary, edited by Martin Wiley. New York, Academic Press, 1977, p.182-215.

The coastal zone of Mexico extends 10,000 kilometers along the borders of the Pacific, Gulf of California, Gulf of Mexico and Caribbean and contains approximately 125 coastal lagoons defined here as: "a coastal zone depression below MHHW, having permanent or ephemeral communication with the sea, but protected from the sea by some type of barrier." Mexican coastal lagoons vary widely in their physical and environmental characteristics and in their degree of man's use and modification. They are geologically

classified according to origin of the depression and barrier characteristics as: I. Differential Erosion (usually drowned valleys but includes solution depressions); II. Differential Terrigenous Sedimentation (typically associated with fluvial/deltaic systems); III. Barred Inner Shelf (offshore barrier on inner continental shelf); IV. Organic (usually coralgal but includes also mangrove and other organisms); V. Tectonic-Volcanic (directly linked with faulting, folding, or volcanism). Many coastal lagoons are compounds of two or more basic classes. Interrelating the original geomorphic characteristics with geologic development history, coastal oceanography and regional climatology, one may predict major types of existing lagoon environmental systems. Brief case studies illustrate the main Mexican coastal lagoon types. References (110 items).

Lean, G.H., and Weare, T.J. Modeling Two-Dimensional Circulating Flow. Journal of the Hydraulics Division, Proceedings, ASCE, vol.105, No.HY1, p.17-26, January 1979. (See annotation in Section VI.)

Lee, T.N., and Rooth, C. Water Movements in Shallow Coastal Bays and Estuaries. University of Miami Sea Grant Program, Coastal Zone Management Bulletin Number 3, January 1973.

A modular approach to the analysis of mixing and flow characteristics in shallow tidal estuaries is presented using as an example the South Florida Biscayne Bay estuary. The method depends on isolating relatively simple characteristic flow regimes in different parts of an estuary. These can be considered as building blocks which, when recombined in different configurations, are capable of yielding a qualitative model for any specific estuary. In Card Sound and South Biscayne Bay, tidal-induced mixing is separated into two flow regions: the interior of the basins and the regions in the vicinity of the tidal inlets. Asymmetric, reversing tidal flow in the interior produces a preferred mixing in the direction of flow which enhances downstream diffusion, resulting in salinity patterns aligned with the direction of flow. This effect inhibits direct exchange with the ocean, producing very long residence times in the interior. Direct exchange between the basins and the ocean takes place in a region near the inlets defined by a semicircle with a radius approximately 500 times the depth of the inlets. Wind effects were found to have a great influence on exchange processes in shallow estuaries. Wind effects mix the estuary horizontally and vertically and can set up a mean circulation that transports interior water into the direct exchange region of the tidal inlets, thereby substantially decreasing the basins residence time. References (2 items).

Lee, Y.S. A Mathematical Model of Unsteady, Two-Layer Flow in a Highly Stratified, Variable-Area, Tidal Estuary. Ph.D. Dissertation, Mississippi State University, Department of Civil Engineering, August 1975. (See annotation in Section VI.)

Leendertse, J.J., and Liu, S.-K. Comparison of Observed Estuarine Tide Data with Hydraulic Model Data by Use of Cross-Spectral Density Functions. The New York City Rand Institute, R-1612-NYC, September 1974. (See annotation in Section VI.)

Leendertse, J.J., and Liu, S.-K. Modeling of Three-Dimensional Flows in Estuaries. Symposium on Modeling Techniques, 2nd Annual Symposium of the Waterways, Harbors and Coastal Engineering Division of ASCE, San Francisco, California, September 3-5, 1975, vol.I, p.625-642. (See annotation in Section VI.)

Leendertse, J.J., and Liu, S.-K. A Three-Dimensional Model for Estuaries and Coastal Seas: Volume II, Aspects of Computation. The Rand Corporation, R-1764-OWRT, June 1975. (See annotation in Section VI).

Leendertse, J.J., and Liu, S.-K. A Three-Dimensional Model for Estuaries and Coastal Seas: Volume IV, Turbulent Energy Computation. The Rand Corporation, R-2187-OWRT, May 1977. (See annotation in Section VI.)

Leendertse, J.J., and Liu, S.-K. A Three-Dimensional Turbulent Energy Model for Nonhomogeneous Estuaries and Coastal Sea Systems. Hydrodynamics of Estuaries and Fjords; Proceedings of the 9th Liege Colloquium on Ocean Hydrodynamics, 1977, p.387-405.

Three-dimensional flows in water bodies with nonhomogeneous density can be computed effectively by use of a finite difference model which contains an equation of continuity, equations describing conservation of momentum, salinity, temperature, subgridscale energy, and an equation of state. In the model, vertical accelerations are neglected, but not the

vertical velocities. The vertical exchange coefficients are computed from the subgridscale energy intensity. The introduction of turbulence closure by computing vertical exchange coefficients in the transport equations eliminates the necessity of evaluating exchange coefficients in the whole computation field, but rather requires the evaluation of only a few characteristic parameters. Experiments made with the model produced velocity distributions which typically occur in coastal areas. References (8 items).

Leendertse, J.J., and Liu, S.-K. A Water-Quality Simulation Model for Well Mixed Estuaries and Coastal Seas: Volume VI, Simulation, Observation, and State Estimation. The New York City Rand Institute, R-1586-NYC, September 1974. (See annotation in Section VI.)

Leendertse, J.J., and Liu, S.-K. A Water-Quality Simulation Model for Well Mixed Estuaries and Coastal Seas: Volume VII, A Hindcast. Rand Institute, New York City, R-1774-NYC, July 1975. (See annotation in Section VI.)

Leendertse, J.J., and Liu, S.-K. A Water-Quality Simulation Model for Well Mixed Estuaries and Coastal Seas: Volume VIII, An Engineering Assessment. The New York City Rand Institute, R-1791-NYC, December 1975. (See annotation in Section IV.)

Leendertse, J.J., Alexander, R.C., and Liu, S.-K. A Three-Dimensional Model for Estuaries and Coastal Seas: Volume I, Principles of Computation. The Rand Corporation, R-1417-OWRR, December 1973. (See annotation in Section VI.)

Leendertse, J.J., Liu, S.-K., and Nelson, A.B. A Three-Dimensional Model for Estuaries and Coastal Seas: Volume III, The Interim Program. The Rand Corporation, R-1884-OWRT, October 1975. (See annotation in Section VI.)

Lehmann, E.J., Editor. Thermal Pollution. Part 3. Hydrology and Hydrodynamics (A Bibliography with Abstracts). Search Period Covered 1964 - March 1976. National Technical Information Service, Springfield, Va., March 1976. NTIS/PS-76/0130 (Supersedes NTIS/PS-75/220). (See annotation in Section IV.)

Lepetit, J.-P., Cazenave, M., and Davesne, M. Complementarité des modèles physique et mathématique pour l'étude de l'échauffement d'un estuaire sur un site de centrale électrique. Proceedings, XVIth Congress of the International Association for Hydraulic Research, São Paulo, Brazil, July 27 to August 1, 1975, vol.3, Paper C22. (In French.) (See annotation in Section VI.)

Lespine, E. Aménagement de l'estuaire de la Gironde (Development of the Gironde Estuary). LA HOUILLE BLANCHE, vol.29, No.1/2, p.71-78, 1974. (In French.) (See annotation in Section VI.)

Liu, P.L.-F., and Lennon, G.P. Finite Element Modeling of Nearshore Currents. Journal of the Waterway, Port, Coastal and Ocean Division, Proceedings, ASCE, vol.104, No.WW2, p.175-189, May 1978. (See annotation in Section VI.)

Liu, S.-K., and Nelson, A.B. A Three-Dimensional Model for Estuaries and Coastal Seas: Volume V, Turbulent Energy Program. The Rand Corporation, R-2188-OWRT, May 1977. (See annotation in Section VI.)

Long, R.R. Lectures on Estuarine Circulations and Mass Distributions. The Johns Hopkins University, Departments of Earth & Planetary Sciences and Mechanics & Materials Science, Technical Report No.9 (Series C), December 1976.

The report is concerned with the physical aspects of estuaries. A semi-enclosed coastal body of water which has a free connection with the open sea and is a mixture of salt water and fresh water. It usually possesses an estuarine circulation of an outflow in the upper layer composed of a mixture of salt water and fresh water and an inflow in the lower layers characterized by saltier sea water. This report will attempt to clarify to some extent the problem of classifying estuaries. References, p.69-72.

Long, R.R. Lectures on Turbulence and Mixing Processes in Stratified Fluids. The Johns Hopkins University, Departments of Mechanics & Materials Science and Earth & Planetary Sciences, Technical Report No.6 (Series C), October 1974.

This is a set of notes based on a set of lectures for a summer course "Vertical Exchange Processes in the Sea." Topic (i) gives a background discussion of basic fluid mechanical problems and simple turbulence theory. Topic (ii) discusses mixing in a stably stratified fluid.

Topic (iii) is concerned with the Richardson number, the flux Richardson number and eddy coefficients of viscosity and buoyancy together with a discussion of mass and salt transfers at the mouth of an estuary and a determination of the depth of the halocline in an estuary. Topic (iv) contains a discussion of the surface layer of the atmosphere. Topic (v) discusses density currents and wake collapse. Topic (vi) involves problems in which the earth's rotation is important. References at end of each topic.

Long, R.R. Mass and Salt Transfers and Halocline Depths in an Estuary. TELLUS, vol.28, No.5, p.460-472, 1976.

The paper considers fluxes of brackish and ocean water out of and into an estuary as well as the depth of the halocline in the estuary. The discussion ignores the details of the mass distribution and circulations in the main body of the estuary (except for the halocline depth) and concentrates on determining the flow conditions and interface depths in the vicinity of the mouth. The flow there is considered to be frictionless and the pressure hydrostatic, and the first part of the analysis, which assumes strong mixing (and, therefore, a deep halocline) in the estuary, yields the same results as those of Stommel and Farmer for their "overmixed" state. Phenomena in this state are determined by a non-dimensional number Q proportional to the fresh water influx q_f. On the other hand, the problem can also be solved when the mixing is zero. The two extreme cases suggest a dependence on a mixing number M for arbitrary mixing. This permits a complete solution for the ocean water flux, brackish water flux, depth of the interface at the mouth, salinity of the brackish water, depth of the halocline in the main body of the estuary and height above sea level of the free surface in the estuary, all as functions of Q_f and M. An interesting feature of all solutions is the main halocline depth which always becomes large for both weak and strong fresh water fluxes and therefore has a minimum at a value q_{fm} which varies with M. This behavior has been observed in Alberni Inlet in British Columbia and in a laboratory experiment by Welander. Comparison of theory with the Baltic Sea leads to some numerical results and speculations. References (28 items).

Long, R.R. On the Depth of the Halocline in an Estuary. JOURNAL OF PHYSICAL OCEANOGRAPHY, vol.5, No.3, p.551-554, July 1975.

Long, R.R. Three-Layer Circulations in Estuaries and Harbors. The Johns Hopkins University, Departments of Mechanics & Materials Science and Earth & Planetary Sciences, Technical Report No. 8 (Series C), September 1976.

A theory is developed for the three-layer circulation in an overmixed estuary (finite fresh-water influx) or harbor (zero fresh-water influx) accompanying a two-layer structure in the large body of water outside. A determinate set of algebraic equations is derived for the general case and the form of the equations shows that for zero fresh-water influx the discharge from a harbor is proportional to the square root of the density difference between the two outside fluids. The problem is solved completely when there is a uniform depth of the fluids inside and outside the harbor, when the fresh-water influx is zero and when the two layers of fluid outside the harbor are of equal thicknesses. A laboratory model reproduced the three-layer circulation of the theory. References (9 items).

Long, R.R. Three-Layer Circulations in Estuaries and Harbors. JOURNAL OF PHYSICAL OCEANOGRAPHY, vol.7, No.3, p.415-421, May 1977.

A theory is developed for the three-layer circulation in an overmixed estuary (finite fresh-water influx) or harbor (zero fresh-water influx) accompanying a two-layer structure in the large body of water outside. A determinate set of algebraic equations is derived for the general case and the form of the equations shows that for zero fresh-water influx the discharge q_1 from a harbor is proportional to the square root of the density difference between the two outside fluids. The problem is solved completely when there is a uniform depth H of the fluids inside and outside the harbor, when the fresh-water influx is zero, and when the two layers of fluid outside the harbor are of equal thicknesses. The solution shows that the outflowing layer of water has a thickness $d = H/2$ and a flux $q_1 = HW(H\Delta b_0)^{\frac{1}{2}}/8$, where W is the width at the constriction and Δb_0 the buoyancy difference between the two outside layers of water. A laboratory model reproduced the three-layer circulation of the theory. The outflowing fluid was quite turbulent and this made the observation of the layer thickness uncertain but it appeared to be close to the value $d = H/2$ of the theory. References (10 items).

Longhurst, A.R. Ecological Models in Estuarine Management. OCEAN MANAGEMENT, vol.4, No.2-4, p.287-302, December 1978. (See annotation in Section VI.)

Love, P. Estuary & Foreshore Planning in Christchurch. SOIL & WATER, vol.14, No.5, p.18-19, October 1978. (See annotation in Section V.)

Lucas, A.H., and Cathers, B. Navigable Harbour Entrances Analysed by Hydraulic Models. Proceedings, XVIth Congress of the International Association for Hydraulic Research, São Paulo, Brazil, July 27 to August 1, 1975, vol.1, Paper A17. (See annotation in Section VI.)

Ludwick, J.C. Variations in Boundary Drag Coefficient in the Tidal Entrance to Chesapeake Bay, Virginia. Institute of Oceanography, Old Dominion University, Norfolk, Virginia, Technical Report No.19, August 1974.

Use of the quadratic shear stress law for estimating boundary drag requires specific knowledge of the magnitude of a drag coefficient, C_D, and sectional mean velocity, $\bar{u}$. In previous attempts to adapt the relationship for use in marine sediment transport studies, the flow measurement has been standardized at a level 100 cm above the bed. The particularized value of the drag coefficient has been designated as C_{100}. In the entrance area to Chesapeake Bay, Virginia, C_{100} has been found to range over unacceptably wide limits. Two-thirds of the values obtained are between 3.5×10^{-3} and 5.4×10^{-2}. Mean C_{100} for the area is 1.3×10^{-2} as compared to 3×10^{-3} for tidal channels within Puget Sound, Washington. Present data suggest that given a moveable bed, a size hierarchy of mobile bed forms, time varying flow, and a lack of equilibrium between flow and bed, C_{100} changes continuously with the flow. Accurate evaluation of boundary shear stress in tidal entrances with high flow rates and mobile beds presently requires measurement of velocity profiles. References (13 items).

Lutz, G.A., Hubbell, D.W., and Stevens, H.H., Jr. Discharge and Flow Distribution, Columbia River Estuary. U.S. Geological Survey, Professional Paper 433-P, 1975. (See annotation in Section VIII.)

Lynch, D.R., and Gray, W.G. Analytic Solutions for Computer Flow Model Testing. Journal of the Hydraulics Division, Proceedings, ASCE, vol.104, No.HY10, p.1409-1428, October 1978. (See annotation in Section VI.)

Maddock, L., and Pingree, R.D. Numerical Simulation of the Portland Tidal Eddies. ESTUARINE AND COASTAL MARINE SCIENCE, vol.6, No.4, p.353-363, April 1978. (See annotation in Section VI.)

Masch, F.D., and Brandes, R.J. Simulation of Tidal Hydraulics - Masonboro Inlet. Symposium on Modeling Techniques, 2nd Annual Symposium of the Waterways, Harbors and Coastal Engineering Division of ASCE, San Francisco, California, September 3-5, 1975, vol.I, p.220-239. (See annotation in Section VI.)

Mattis, W.E., and Klafter, R.D. Optimal Waste Discharge in Estuaries and Bays. International Federation of Automation Control, World Congress, 5th, held in Paris, France, June 12-17, 1972, Proceedings, Part 3, Paper 9.2. (See annotation in Section IV.)

Mauvais, J.-L., and Salomon, J.-C. Etude du frottement en Loire maritime (Study of Frictional Effects in the Loire Maritime Estuary). LA HOUILLE BLANCHE, vol.29, No.1/2, p.149-154, 1974. (In French.)

This study of friction (one of the most important tidal propagation terms) was carried out in two different ways: (a) A local study by measuring velocity gradients above the bed. Determination of flow parameter variations with tide coefficient and river bed material size. (b) A general study of frictional effects in the estuary by solving the dynamic equations. The following are known (i) Stage data for the whole estuary (by interpolation of tide recorder data). (ii) Discharge at various cross-sections (cubic volume calculation method). Hence, friction can be determined and statistically analyzed. Bibliography (3 items). With discussion.

Mavrigian, G., Sarikelle, S., and Carpenter, J.W. Circulation Patterns Behind a Porous Breakwater. Sixth Annual Offshore Technology Conference, May 6-8, 1974, Houston, Texas, Preprints, vol.II, Paper Number OTC 2123, p.943-950. (See annotation in Section VI.)

Mayor-Mora, R. Hydraulics of Tidal Inlets on Sandy Coasts. Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, Copenhagen, Denmark, vol.II, 1975, Chapter 89 (p.1524-1545). (See annotation in Section VI.)

McChesney, S.W., and Edge, B.L. A Mathematical Model for Water Quality Evaluation in the South Carolina Grand Strand. Water Resources Research Institute, Clemson University, South Carolina, Report No.45, September 1976. (See annotation in Section VI.)

McCoy, J.E., and Edge, B.L. Methodology for Applying the Finite Element Method to Partially Stratified Estuaries. Water Resources Research Institute, Clemson University, South Carolina, Report No.66, January 1977.

Since most multi-dimensional flow models ignore parameter variation in the vertical direction, a significant number of physical systems defy prediction due to vertical stratification. A two-dimensional model which predicts constituent transport in stratified estuarine flow systems would enable planners and engineers to determine consequences of proposed modifications to stratified bodies of water. This study attempts to ascertain whether the finite element method can be formulated for a stratified system and then determines a nonlinear numerical analysis based on the finite element approach for an estuarine system. Literature Cited (27 items).

McDowell, D.M., and O'Connor, B.A. Hydraulic Behaviour of Estuaries. New York, John Wiley, 1977.

Chapters 1, 5, 9 and 10 give an account of estuarine behavior; of the care that must be taken in trying to measure it quantitatively; of methods of estuarine management by engineering work; and of the response of several actual estuaries to control work. The other chapters are concerned with mathematical formulation of the behavior of real estuaries and with aids to solution of real problems using physical and mathematical modeling techniques. Describes the physical basis of each technique and demonstrates its use and limitations in dealing with real situations. References.

McGregor, R.C. The Influence of Channel Shape on Shoaling in Tidal Estuaries. Geophysical Journal of the Royal Astronomical Society, vol.36, No.3, p.599-606, March 1974. (See annotation in Section II.)

McHugh, G.F. Development of a Two-Dimensional Hydrodynamic Numerical Model for a Shallow Well-Mixed Estuary. Louisiana State University, Center for Wetland Resources, Sea Grant Publication No. LSU-T-76-008, 1976. (See annotation in Section VI.)

McKay, J.H. The Hydraulic Model of Chesapeake Bay. Estuarine Processes; Volume II, Circulation, Sediments, and Transfer of Material in the Estuary, edited by Martin Wiley. New York, Academic Press, 1977, p.404-415. (See annotation in Section VI.)

Meade, R.H. Landward Transport of Bottom Sediments in Estuaries of the Atlantic Coastal Plain. JOURNAL OF SEDIMENTARY PETROLOGY, vol.39, No.1, p.222-234, March 1969. (See annotation in Section II.)

Mehta, A.J., and Christensen, B.A. Incipient Sediment Motion in Entrances with Shell Beds. In: Rivers '76; Symposium on Inland Waterways for Navigation, Flood Control and Water Diversions; 3rd Annual Symposium of the Waterways, Harbors and Coastal Engineering Division of ASCE, Colorado State University, Fort Collins, August 10-12, 1976, vol.II, p.960-977, 1976. (See annotation in Section VI.)

Mehta, A.J., and Hou, H.S. Hydraulic Constants of Tidal Entrances II: Stability of Long Island Inlets. Coastal and Oceanographic Engineering Laboratory, University of Florida, Technical Report No.23, November 1974. (See annotation in Section II.)

Miles, J.W. Tidal Wave Diffraction by Channels and Bays. GEOPHYSICAL FLUID DYNAMICS, vol.5, p.155-171, 1973.

A Kelvin wave in a semi-infinite ocean with a narrow (compared with the wavelength) continental shelf is diffracted by a narrow gap that feeds any of a second semi-infinite ocean, a semi-infinite channel, a closed channel of finite length, a small bay, or a channel terminated by a bay. An equivalent electrical circuit is constructed, in which the incident-wave displacement in the gap appears as the input voltage and the flow into the gap appears as the input current. Approximations to the elements of this circuit are constructed from a

quadratic functional that is derived from the integral equation implied by the boundary-value problem. The phase shift in the diffracted Kelvin wave is calculated, and numerical results are given for representative configurations. The general results are applicable to other tidal waves in the semi-infinite ocean, e.g., a Poincaré wave. A model of San Francisco Bay, opening into the ocean through a short, narrow channel (the Golden Gate) and fed by rivers through a long channel (Carquinez Straits), is constructed. It yields a resonant period of 4.6h and a time delay of 3.6 sec for a semi-diurnal (12.4h) Kelvin wave. References (17 items).

Miller, G.H., and Berg, D.W. An ERTS-1 Study of Coastal Features on the North Carolina Coast. U.S. Army Corps of Engineers, Coastal Engineering Research Center, Miscellaneous Report No.76-2, January 1976. (See annotation in Section VII.)

Millero, F.J. The Physical Chemistry of Estuaries. Reprint from American Chemical Society Symposium Series, Marine Chemistry in the Coastal Environment, Number 18, p.25-55, 1975.

In recent years a great deal of progress has been made in developing models to examine the physical chemistry of multicomponent electrolyte solutions like seawater. These models have been used to examine the physical chemical properties of seawater and the state of ionic solutes in seawater. In the present paper these models will be briefly reviewed and applied to estuaries. The physical chemical properties of estuaries have been estimated by mixing river water with seawater and assuming that the excess properties of the resulting mixture are equal to zero. These calculations demonstrate that at the same total solid concentration the physical chemical properties of estuaries are equal to those of seawater diluted with pure water. The state of metal ions in estuaries have also been examined by using the ion pairing model for ionic interactions. (Author.) Literature Cited (75 items).

Moes, J. Stability of Small Estuary Mouths. Proceedings, XVIth Congress of the International Association for Hydraulic Research, São Paulo, Brazil, July 27 to August 1, 1975, vol.1, Paper A11. (See annotation in Section VI.)

Mohr, A.W. Energy and Pollution Concerns in Dredging. Journal of the Waterways, Harbors and Coastal Engineering Division, Proc. ASCE, vol.101, No.WW4, p.405-417, November 1975. (See annotation in Section V.)

Muir, L.R. A One-Dimensional Tidal Model for Estuarine Networks. Hydrodynamics of Estuaries and Fjords; Proceedings of the 9th Liege Colloquium on Ocean Hydrodynamics, 1977, p.243-260. (See annotation in Section VI.)

Munday, J.C., Jr., Byrne, R.J., Welch, C.S., et al. Applications of Remote Sensing to Estuarine Problems. Annual Report No.3. Virginia Institute of Marine Science, December 1975. (See annotation in Section VII.)

Munday, J.C., Jr., Gordon, H.H., Welch, C.S., et al. Applications of Remote Sensing to Estuarine Management. Annual Report No.4. Virginia Institute of Marine Science, July 1976. (See annotation in Section VII.)

Murfee, G.W., Fruh, E.G., and Masch, F.D., Jr. Establishment of Operational Guidelines for Texas Coastal Zone Management: Interim Report on Estuarine Modeling. University of Texas at Austin, May 1973. (See annotation in Section VI.)

Murray, S.P., and Wiseman, W.J., Jr. Current Dynamics and Sediment Distribution in the West Mississippi Delta Area. Coastal Studies Institute, Center for Wetland Resources, Louisiana State University, Baton Rouge, A Collection of Reprints, September 1976, Technical Report No.208. Reprint from Conference on Marine and Freshwater Research in Southern Africa, July 1976. (See annotation in Section II.)

Murray, S., Conlon, D., Siripong, A., et al. Circulation and Salinity Distribution in the Rio Guayas Estuary, Ecuador. In: Estuarine Research, Volume II: Geology and Engineering, edited by L. Eugene Cronin, Academic Press, Inc., New York, 1975, p.345-363. (See annotation in Section III.)

Myers, V.A., and Overland, J.E. Storm Tide Frequencies for Cape Fear River. Journal of the Waterway, Port, Coastal and Ocean Division, Proc. ASCE, vol.103, No.WW4, p.519-535, November 1977. (See annotation in Section VI.)

Narayanan, M., and Shankar, N.J. A Numerical Model for the Simulation of Two-Dimensional Convective Dispersion in Shallow Estuaries. Paper presented at the International Symposium on Finite Element Methods in Flow Problems, edited by J.T. Oden, O.C. Zienkiewicz, R.H. Gallagher, and C. Taylor, The University of Alabama at Huntsville, 1974, p.455-458. (See annotation in Section VI.)

National Research Council, Geophysics of Estuaries Panel. Estuaries, Geophysics, and the Environment. National Academy of Sciences, Washington, D.C., 1977. (See annotation in Section IV.)

Nece, R.E., and Knoll, C.R. Flushing and Water Quality Characteristics of Small-Boat Marinas. Charles W. Harris Hydraulics Laboratory, University of Washington, Seattle, Technical Report No.40, June 1974. (See annotation in Section IV.)

Nece, R.E., and Lowthian, R.A. Tidal Circulation Study, Proposed Southeast Harbor Development. Charles W. Harris Hydraulics Laboratory, Department of Civil Engineering, University of Washington, Seattle, Technical Report No.47, January 1976. (See annotation in Section VI.)

Nece, R.E., and Richey, E.P. Application of Physical Tidal Models in Harbor and Marina Design. Symposium on Modeling Techniques, 2nd Annual Symposium of the Waterways, Harbors and Coastal Engineering Division of ASCE, San Francisco, California, September 3-5, 1975, vol.I, p.783-801. (See annotation in Section VI.)

Nece, R.E., Welch, E.B., and Reed, J.R. Flushing Criteria for Salt Water Marinas. Charles W. Harris Hydraulics Laboratory, University of Washington, Seattle, Technical Report No.42, June 1975. (See annotation in Section IV.)

Nielsen, E. Feasibility of Coastal Morphological Models. Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, Copenhagen, Denmark, vol.II, 1975, Chapter 38 (p.663-684). (See annotation in Section VI.)

Nielsen, J.N., and Kuhn, G.D. Application of Boundary-Layer Theory to Dispersion in Nonstratified Two-Dimensional Estuaries. Nielsen Engineering and Research, Incorporated, Report NEAR TR 45, 1973.

An analytical formula representing the law of the wall and the law of the wake of turbulent boundary-layer theory has been found to represent the vertical velocity profiles of both laboratory channels and field data from real estuaries. The formula is used in an integral boundary-layer calculation method to calculate the detailed time-dependent flow field of two-dimensional estuaries. For given tidal information, only the integrated continuity and momentum equations are necessary to calculate the two parameters of the formula. The unique solution is found to pass through one or more singular points between the ends of the estuary. An analytical expression for the concentration profile is derived based on an analogy between turbulent exchange of momentum and mass. Good comparisons between theory and experiment were obtained for the flow field of a laboratory flume. Examination of data for dispersion indicates that the dominant terms of the governing equations are not diffusive in nature but are convective. References (17 items).

Niemeyer, G. Efficient Simulation of Nonlinear Steady Flow. Journal of the Hydraulics Division, Proceedings, ASCE, vol.105, No.HY3, p.185-195, March 1979. (See annotation in Section VI.)

Niemeyer, G. Long Wave Model Independent of Stability Criteria. Journal of the Waterway, Port, Coastal and Ocean Division, Proceedings, ASCE, vol.105, No.WW1, p.51-65, February 1979. (See annotation in Section VI.)

Nihoul, J.C.J., Ronday, F.C., Peters, J.J., et al. Hydrodynamics of the Scheldt Estuary. Hydrodynamics of Estuaries and Fjords; Proceedings of the 9th Liege Colloquium on Ocean Hydrodynamics, 1977, p.27-53.

The Scheldt Estuary is the Southern branch of the Rhine - Meuse - Scheldt delta. The natural evolution of the delta has been, to a large extent, influenced by man's activities: embanking, closing of arms and creation of artificial fresh water lakes. Since the closing in 1867 of the connection with the Western Scheldt, the Scheur and the Oostgat are the only openings of the Eastern Scheldt to the sea. The mouth of the Rhine is situated 80 km to the North. The drainage basin of the Scheldt and its tributaries covers some 21,580 km^2 in the North-West of France, the West of Belgium and the South-West of the Netherlands. The flow of the Scheldt River is

generally small while tidal motions in the estuary are large, producing a fairly good mixing of fresh and sea waters. Downstream of Walsoorden, the river is characterized by a complicated system of channels often referred to as "flood" and "ebb" channels according to how the main water motion occurs during flood-tide or ebb-tide. Such a classification is, in many cases oversimplified, especially for the Middelgat channel and the Gat Van Ossenisse channel between Terneuzen and Hansweert. Upstream of Walsoorden, up to Gentbrugge, the river is characterized by a main channel, well defined, with occasional embryos of secondary channels upstream. References (12 items).

Nittrouer, C.A., and Sternberg, R.W. The Fate of a Fine-Grained Dredge Spoils Deposit in a Tidal Channel of Puget Sound, Washington. JOURNAL OF SEDIMENTARY PETROLOGY, vol.45, No.1, p.160-170, March 1975. (See annotation in Section II.)

O'Brien, M.P. Notes on Tidal Inlets on Sandy Shores. U.S. Army Corps of Engineers, General Investigation of Tidal Inlets, GITI Report 5, February 1976.

A program of research conducted jointly by U.S. Army Coastal Engineering Research Center, Fort Belvoir, Virginia, and U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Report presents observations, theories, and analysis that the author has found applicable to the rational design of coastal inlets. It also presents various memoranda on the behavior and sedimentary and hydraulic characteristics of tidal inlets on sandy shorelines, and is intended to represent a source of ideas for graduate thesis studies, as well as a stimulant to other research workers in this field. Literature Cited (12 items).

O'Brien, M.P., and Clark, R.R. Hydraulic Constants of Tidal Entrances I: Data from NOS Tide Tables, Current Tables and Navigation Charts. Coastal and Oceanographic Engineering Laboratory, University of Florida, Technical Report No.21, November 1973.

Methods used in analyzing flow through tidal entrances on sandy coasts make assumptions regarding the geometry of the inlets and related flow regime, which depart substantially from flow conditions at real entrances. A volume of reduced data on tides, currents and the geometry of tidal entrances is contained in the Tide Tables, Tidal Current Tables and navigation charts of National Ocean Survey. The described approach makes use of these data to characterize the flow in real inlets by means of empirical coefficients which are defined by a simple flow relationship. The evaluation of the published data pertaining to the hydraulics of entrances indicates that the data are sufficiently accurate and representative, despite some yet unexplained discrepancies, to permit the determination of discharge coefficients of inlets, and to identify categories of entrances with characteristic flow regimes. References (22 items).

O'Brien, M.P., and Clark, R.R. Hydraulic Constants of Tidal Entrances. Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, Copenhagen, Denmark, vol.II, 1975, Chapter 90 (p.1546-1565).

Data contained in the Tide Tables, Current Tables and navigation charts of National Ocean Survey pertaining to tidal entrances along the coasts of the continental United States are analyzed to obtain flow coefficients defined by a simple hydraulic equation. The evaluation of the published data indicates that the data are sufficiently accurate and representative, despite some unexplained anomalies, to permit determination of the approximate discharge coefficients and, more importantly, to identify categories of flow regimes of inlets. A few conclusions are: 1. The Keulegan approach and similar analyses of inlet hydraulics provide a useful qualitative framework for ordering data but they apply quantitatively only to small inlets and lagoons with simple inlet channel geometry. 2. The lag of slack water in the entrance channel after HW and LW is a powerful tool in the analysis of the hydraulic regime. It is easily measured in the field and should become an identifying characteristic of each entrance. 3. The resistance coefficient F represents the overall impedance and exit losses, reflections from the lagoon shore, fresh water discharge and the configuration of the channel between the inner and outer bars. It may be determined from measurements of lag and maximum velocity at the throat and the range of ocean tide. References (6 items).

O'Connor, B.A. Sediment Intrusion in a Tidal Lock. Proceedings, XVIth Congress of the International Association for Hydraulic Research, São Paulo, Brazil, July 27 to August 1, 1975, vol.3, Paper C35. (See annotation in Section VI.)

O'Connor, B.A., and Zein, S. Numerical Modelling of Suspended Sediment.

Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, Copenhagen, Denmark, vol.II, 1975, Chapter 65 (p.1109-1128). (See annotation in Section VI.)

Oertel, G.F. Post Pleistocene Island and Inlet Adjustment Along the Georgia Coast. JOURNAL OF SEDIMENTARY PETROLOGY, vol.45, No.1, p.150-159, March 1975. (See annotation in Section II.)

Officer, C.B. Physical Oceanography of Estuaries. OCEANUS, vol.19, No.5, p.3-9, Fall 1976.

Scientific understanding of the physics, chemistry, geology, and biology of estuaries is inadequate for making environmental decisions. Estuarine hydrodynamics and applications are discussed. The importance of tidal motions is stressed. Interest in the geophysics of estuaries is increasing among researchers. References (7 items).

Officer, C.B. Physical Oceanography of Estuaries (and Associated Coastal Waters). New York, John Wiley, 1976.

This book gives a coordinated treatment of the physical oceanography of estuaries and related bodies of water, such as tidal rivers, straits, bays, and lagoons. The emphasis is first on the mathematical theory and second on applications of the theory by various investigators to particular estuarine problems. Some of the topics include Hydrodynamics, Tidal Phenomena, Circulation, Mixing, and Pollutant Dispersion. Some of the applications in Great Britain, Europe, Americas (both East and West Coast), Asia, Australia, and Japan are discussed. The approach of the book is toward an analytical description of the physical processes involved. Little mention is made of computer or physical models and modeling techniques. Bibliography, p.441-454.

Ohlmeyer, F., and Berndt, D. Field and Model Data of Spreading in Estuaries. Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, Copenhagen, Denmark, vol.III, 1975, Chapter 137 (p.2357-2367). (See annotation in Section VI.)

Olufeagba, B.J., Flake, R.H., and Armstrong, N.E. A Boundary Value Approach for Estuarine Water Quality Modelling with Results for Jamaica Bay, New York. ECOLOGICAL MODELLING, vol.1, No.1, p.3-30, May 1975. (See annotation in Section VI.)

Ordonez, J.I. Modeling Sediment Deposition in a Tidal River. Symposium on Modeling Techniques, 2nd Annual Symposium of the Waterways, Harbors and Coastal Engineering Division of ASCE, San Francisco, California, September 3-5, 1975, vol.II, p.1347-1368. (See annotation in Section VI.)

Orlob, G.T. Impact of Upstream Storage and Diversions on Salinity Balance in Estuaries. Estuarine Processes; Volume II, Circulation, Sediments, and Transfer of Material in the Estuary, edited by Martin Wiley. New York, Academic Press, 1977, p.3-17. (See annotation in Section IV.)

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Overland, J.E., and Myers, V.A. Model of Hurricane Tide in Cape Fear Estuary. Journal of the Waterways, Harbors and Coastal Engineering Division, Proc. ASCE, vol.102, No.WW4, p.407-424, November 1976. (See annotation in Section VI.)

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Wave scattering characteristics of narrow openings such as tidal inlets, tsunami breakwaters, and harbor entrances are studied experimentally. Flow separation and generation of jets and vortices in the near field of the opening determines the subsequent loss of energy and the far-field scattering properties. The non-linear behavior of a narrow opening in the presence of flow is analyzed in an approximate manner. Experimental procedures are complicated by shallow water distortion of the waves. To overcome this difficulty the measured waveforms are Fourier analyzed and the spacial amplitude variations of the incident and reflected harmonics obtained. The transmission of waves is reduced by the inertial reactance of the opening, and by

flow separation. When inertial reactance is dominant, the response is selective of frequency. However, when the flow separation is significant, wave transmission becomes dependent on amplitude only. The dissipation of energy is maximal in the second case. References (29 items).

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The flow and mass transport associated with turbulent jets ebbing from tidal inlets are analyzed by including the effects of frictional resistance and topographical variations of the bottom, ambient cross-currents and concentrations, and settling to the bottom. The retardation of the jet due to bottom friction results in a rapid expansion that is considerably faster than in the case of a classical jet. An offshore-sloping bottom topography opposes this effect. Dilution within the jet is suppressed due to friction, and enchanced by an offshore sloping bottom. In the case of sediments, finer sediments are transported to further offshore as compared to coarser sediments. Largest depositions occur near marginal shoals. Deep scouring may occur near the mouth region at times of extreme flows. These results and their implications on the geomorphology near tidal inlets and river mouths are discussed. References (45 items).

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Pearce, B.R., and Christodoulou, G.C. Application of a Finite Element Dispersion Model for Coastal Waters. Proceedings, XVIth Congress of the International Association for Hydraulic Research, São Paulo, Brazil, July 27 to August 1, 1975, vol.1, Paper A4. (See annotation in Section VI.)

Pearson, C.E., and Winter, D.F. Computation of Tidal Flow in Well-Mixed Estuaries. Journal of the Hydraulics Division, Proc. ASCE, vol.102, No.HY3, p.367-377, March 1976.

A new efficient procedure is developed for computing periodic flow in well-mixed estuaries of arbitrary geometry. A harmonic analysis is performed in which accurate representations of the nonlinear terms in the equations of motion are developed by successive approximation. At each iteration, the modal coefficients satisfy a system of first-order equations and boundary conditions which are combined in such a way as to promote algorithmic efficiency. The method is illustrated by applications to a model river estuary and to a deep inlet with a sill. Accuracy is demonstrated for the former case (where nonlinear effects are strong) by close agreement with results obtained from a time-stepping method. The method appears to be very efficient, and computation time may be less than 10% of that required by conventional time-stepping procedures. Analysis of multiple branches and networks of estuaries is also considered. References (11 items).

Pearson, C.E., and Winter, D.F. On the Calculation of Tidal Currents in Homogeneous Estuaries. JOURNAL OF PHYSICAL OCEANOGGRAPHY, vol.7, No.4, p.520-531, July 1977.

The paper describes a new approach to the computation of tidal flow in homogeneous

estuaries with irregular boundary configurations and of arbitrary depth. The governing equations are the standard vertically integrated expressions of momentum and mass conservation including the effects of Coriolis acceleration, surface wind stress and bottom friction. The motion is assumed to be periodic and the original time-dependent equations are replaced by a set of modal equations obtained by Fourier decomposition, with the nonlinear terms being treated by an iteration technique. Two types of boundary conditions at the junction of the estuary with the sea are considered: 1) the specification of tidal height as a function of time across the mouth, and 2) continuity of height and velocity at the mouth when a source at sea generates waves propagating toward the estuary. It is shown that the boundary value problems as expressed by the modal equations and the boundary conditions in each case can be rephrased in terms of variational principles. The variational principle is then used together with a finite element method to solve for the unknown variables--water surface height and depth-averaged velocities. For the purpose of illustration the method is applied to estuaries with semi-elliptical boundaries and various bottom profiles. It appears that the method can provide both computational speed and numerical accuracy in a wide variety of problems of practical interest References (14 items).

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In deep, narrow, fjord-type inlets with copious runoff near the head, freshwater inflow produces a surface slope and a pressure gradient which drives a brackish, near-surface layer seaward; at greater depths a denser, saline layer derived from oceanic water moves landward. The paper describes a self-consistent two-layer representation of this mode of inlet flow, generally referred to as "estuarine circulation." Our approach is different from other layered analyses in that the present model includes important effects of variations in mass density, channel width and depth, and also allows for turbulent and advective exchange between the deep and near-surface layers. The starting point of the analysis is a set of equations expressing incompressibility and conservation of mass and horizontal momentum in each zone. Transfer of mass and momentum across the interface between the layers is parameterized by two interzonal exchange flux rates, F_u and F_d, representing the upward and downward rate of fluid flow per square meter of interfacial area. When the time-averaged mass density variations can be estimated from field data, then the flux rates, F_u and F_d, can be inferred entirely from known or measurable quantities. Two integrals of the motion are immediately available, and the mathematical problem is reduced to solving a pair of nonlinear equations for the layer cross-sectional areas. By way of illustration, the procedure is applied to Knight Inlet, a deep, stratified fjord on the Pacific Northwest coastline. References (10 items).

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Measurements in fjords and in laboratories as well as theories show clearly that the basic assumption in all the present theories concerning similarity is not fulfilled. Further on, it has been demonstrated that an approach using an interfacial shear stress and an entrainment function is sufficient. This gain in knowledge could not have been obtained without the present theories. The next step in developing a fjord theory is to cancel the similarity assumptions concerning the velocity and density profiles. This demands that quite new ideas are introduced in the fjord theories. One practical way is to extend the set of equations by the conservation equations for the turbulent kinetic energy, the Reynolds' shear stress, the mass deficit flux, etc. In this way it may be possible to set up a general fjord theory applicable to all types of fjords. The only problem is how to simulate the conservation equation for the turbulent properties. A first step in this direction has been made by the author. If we confine ourselves to the interfacial equilibrium layer for type 1 fjords, the extended sets of equations can be solved analytically. In this way the following quantities have been evaluated: The eddy viscosity for momentum and salt, the velocity and the density gradient, the Monin-Ubokhov length scale, the dissipation length scale, the

Brunt-Väiäsäla frequency, the gradient and the flux Richardson number. It is probably impossible to go much further analytically, but by means of computers the way is prepared for further progress in fjord models. References (13 items).

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A time-dependent numerical model, which treats fully evolved wind-driven canopy flow as a coupled two-layer system, is developed. The interfacial stress is formulated in terms of a coupling coefficient and the flow differential. The resistance afforded by a vegetative canopy is parameterized in terms of a drag coefficient and dimensional properties of the canopy elements. With flow confined strictly to the canopy, the calming effect of the canopy is introduced through a sheltering coefficient. The canopy is modeled as a set of rigid uniform structures oriented normal to the flow and evenly distributed with specified density over the bottom. The algorithm is tested by simulating the steady-state water-surface profiles observed in a laboratory channel containing wire screen obstructions. The model is applied next to a wind-driven rectangular basin with simulated vegetation specified over half the bottom. References (6 items).

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A quasi-linearized, steady-state model of nutrient-phytoplankton interactions has been constructed for the Chesapeake Bay system to provide a first basis for allocation of nutrient discharges. The results of the data and model evaluations indicate that phosphorus rather than

nitrogen generally is the limiting nutrient for phytoplankton growth in the Chesapeake Bay above the Potomac River. The most significant sources of nutrients to the bay are from the Baltimore metropolitan area and the Susquehanna River. For the periods analyzed, it was estimated from the model verification analysis that 50 and 10% of the total phosphorus inputted to Baltimore Harbor and the Back River, respectively, reach the Chesapeake Bay. Estimates of the impact on phytoplankton biomass, as measured by chlorophyll a, as a result of reduced phosphorus discharges are determined from the model for different regions of the bay. References (8 items).

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Recording current meter data from two approximately one-month periods are used to investigate non-tidal exchanges between Corpus Christi Bay, Texas, and the northwestern Gulf of Mexico. The net transport in May and June 1975 is an outflow which appears to be driven primarily by slowly falling coastal water levels. Rising coastal water levels in July 1976 appear to be responsible for a net inflow into the bay. In each study, non-tidal current variations, occurring over time scales on the order of three to six days, are superimposed onto the very long period net transport. Related studies in the same area suggest that these estuarine-shelf exchanges are in response to meso-scale meteorological forcing. Dominant processes include the set-up and set-down of coastal water levels by cross-shelf windstress, a cross-shelf Ekman transport produced by longshore windstress, and an inverse barometer effect. References (9 items).

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The rates of ammonia and urea release by selected species of copepods collected from the estuary at Beaufort, North Carolina, during September through April in 1973 and 1974 varied with species, sex, season, and feeding state. The rate of ammonia assimilation by phytoplankton was greatest in September and April, and there were no significant differences associated with tidal changes. Rates of

ammonia assimilation by phytoplankton ranged from 1 to 101 mg N m^{-3} day^{-1} while ammonia release by zooplankton ranged from 0.1 to 9.7 mg N m^{-3} day^{-1}. The productivity of the phytoplankton in the estuary must depend largely upon regenerated nitrogen since the maximum rate of assimilation of ammonia by phytoplankton was often the same as total-nitrogen uptake estimated from primary productivity. The average rate of ammonia release by zooplankton was 8% of the average ammonia assimilation by phytoplankton. I conclude that, while all sources of regenerated nitrogen are used and therefore of value in a system depending almost totally upon regeneration, zooplankton are not the major source of regenerated nitrogen in this estuary. References (29 items).

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Pollutants moving with undiluted offshore water can approach a tidal inlet for most part of the tidal cycle. During flooding tide, a wave-induced longshore current arriving from the adjacent surf zone is readily entrained into the inlet, whereas an ambient cross current, either driven by tide or sea breeze, tends to bypass the inlet by deflecting seaward at the jetty. During ebb tide, these currents can still operate in strength in the underlayer, bypassing the inlet beneath the buoyant jet or approaching the inlet under a laterally expanding effluent along the adjacent surf zone. The effluent discharging with the jet can undergo strong buoyant expansion into the adjacent coast, forming a partially diluted effluent pool against the shore under a sea breeze. The land breeze and the instability at the density boundary between this nearshore effluent pool and the undiluted off-shore water are the two most important factors affecting the eventual dispersion and diffusion of the tidal inlet effluent. References (6 items).

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Stevenson, J.C., Heinle, D.R., Flemer, D.A. et al. Nutrient Exchanges Between Brackish Water Marshes and the Estuary. Estuarine Processes; Volume II, Circulation, Sediments, and Transfer of Material in the Estuary, edited by Martin Wiley. New York, Academic Press, 1977, p.219-240.

Two irregularly flooded brackish marshes of the Chesapeake Bay estuarine system were studied to detect patterns of tidal nutrient exchange and utilization. A 5.7 ha marsh on the Choptank River was monitored monthly from October 1974 to August 1975 for dissolved inorganic nitrogen and phosphorus. During these diurnal samplings, nutrient exchange with the estuary was eliminated by a tidal gate and total aquatic oxygen metabolism was measured. During winter, photosynthesis exceeded respiration, and total nitrogen increased to 80 µg-at $liter^{-1}$ and the declined through spring to 8 µg-at $liter^{-1}$. Phosphate varied erratically from 0.8 to 4.3 µg-at $liter^{-1}$. Tidal import and export of the above nutrients were also monitored monthly from January to June 1975. During winter, there appears to be a net flow of inorganic nitrogen and phosphorus to the estuary. In spring this pattern is reversed for both nutrients. Two years tidal flow data from a larger 127 ha marsh on the

Patuxent River revealed that dissolved inorganic nitrogen is also taken up in May, June and July. However, when the dissolved organic fraction is also considered, net nitrogen flow was always to the estuary in every month sampled. It is estimated that the dissolved nitrogen flux from the marsh was 4.14 g m^{-2} yr^{-1}, or about 18-82% of the estimated nitrogen of the vegetation. Also, the net annual flux of dissolved phosphorus was 0.19 g m^{-2} yr^{-1} to the estuary or 8-23% of the phosphorus in standing crop. Data from both marshes suggest that, in contrast to previously studied high salinity marshes, brackish marshes act more as sources of nutrients to the estuary. However, these marshes may be trapping some nutrients, either from upland areas surrounding them, or possibly from infrequent massive river deposition. References (42 items).

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A simple theory shows that the two-layer transport capacity of a constriction may be increased considerably by barotropic current fluctuations. This is confirmed by laboratory experiments. The effect may be of great importance for the deep-water renewal process in some sill fjords and for the hydrographic conditions in some overmixed estuaries. References (6 items).

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Sullivan, R.H. The Effect of Tidal Currents on Planned Effluent Discharge in Puget Sound. Ocean 75 Record: 1975 IEEE Conference on Engineering in the Ocean Environment, and Eleventh Annual Meeting of the Marine Technology Society, San Diego, California, September 22-25, 1975, p.940-943. (See annotation in Section IV.)

Sumer, S.M., and Fischer, H.B. Transverse Mixing in Partially Stratified Flow. Journal of the Hydraulics Division, Proc. ASCE, vol.103, No.HY6, p.587-600, June 1977. (See annotation in Section VI.)

Sündermann, J. A Three Dimensional Model of a Homogeneous Estuary. Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, Copenhagen, Denmark, vol.III, 1975, Chapter 136 (p.2337-2356). (See annotation in Section VI.)

Sündermann, J., Wulzinger, W., and Vollmers, H. The Effect of Dam Constriction on Tidal Processes in an Estuary. Proceedings, XVIth Congress of the International Association for Hydraulic Research, São Paulo, Brazil, July 27 to August 1, 1975, vol.1, Paper A12. (See annotation in Section VI.)

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Talbot, J.W., and Talbot, G.A. Diffusion in Shallow Seas and in English Coastal and Estuarine Waters. Proceedings, Symposium, Physical Processes Responsible for Disperal of Pollutants in the Sea, with Special Reference to the Near-Shore Zone, held in Arhus, Denmark, 4-7 July 1972, p.93-110. Copenhagen, Denmark, December 1974.

Diffusion measurements in estuarine, coastal and open-sea waters around England are discussed. The results are classified as simple or complex, depending on the relative importance of moderate-scale eddies. The importance of vertical shear diffusion associated with

the tidal oscillation is considered, with particular regard to the cases showing simple behavior. References (10 items)

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Measurements of the exchange characteristics at tidal inlets are presented and interpreted in the framework of an idealized conceptual model. The conceptual model considers the primary cause of exchange to be the result of the differences in flow patterns away from and toward an inlet. The efflux from an inlet is considered to occur as a separated flow whereas a sink-type attached pattern is assumed for flow toward the inlet. The combined results of these two patterns is an effective lateral mixing. Field measurements were conducted from an anchored boat and a dye injection and monitoring approach were utilized. The measured results, expressed as "Basin Mixing Coefficients" are presented for three inlets and are interpreted in terms of the geometric and flow characteristics of the inlet and adjacent waters. References (4 items).

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Thorn, M.F.C. Deep Tidal Flow over a Fine Sand Bed. Proceedings, XVIth Congress of the International Association for Hydraulic Research, São Paulo, Brazil, July 27 to August 1, 1975, vol.1, Paper A27. (See annotation in Section II.)

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The method of characteristics is seen in the context of other techniques as a rather basic tool in the (x-y-t) tidal situation. Its principal disadvantages appear to be the CFL (Courant-Friedrichs-Lewy) restriction on time step and computational speed. However, all variables are dealt with at the same point, which may perhaps represent some advantage over staggered grid methods. Results obtained by applying the method to a relatively coarse representation of an estuary were in broad agreement with measurements taken from a physical model. An explicit version of the convective diffusion equation was coupled to the long wave system and certain features of float movement were reproduced by the action of the convective terms alone. The acquisition of sufficient data for confident simulation of estuary processes represents a considerable task in itself. The method of characteristics could be a convenient framework for the manipulation of such data. References (29 items).

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During October 1972 the Patuxent River Estuary was monitored intensively and synoptically over two tidal cycles to determine the spatial and temporal patterns of various hydrodynamic, chemical and biological features. Forty-one depths at eleven stations along nine transects were sampled simultaneously at hourly intervals for salinity, temperature, dissolved oxygen, chlorophyll a, particulate nitrogen, nitrate, nitrite, total kjeldahl nitrogen, ammonia, particulate carbohydrate, dissolved organic carbon, total hydrolizable phosphorous, dissolved inorganic phosphorous, suspended sediment, particle size distribution, and zooplankton. Tidal velocity was continuously monitored at each depth by recording current meters. Riverine input and meteorological conditions were relatively stable for two weeks preceeding the deployment. This communication describes the calculation of the intrinsic rates of change of the observed variables from their measured distributions in the Estuary. The steady-state, one-dimensional equation of species continuity is employed to separate the advection and tidal dispersion of a hydrodynamically passive substance from its intrinsic rate of change at point. A new spatial transform is introduced for the purpose of interpolation and extrapolation of data. The intrinsic rate of change profiles reveals a region of heavy bloom activity in

the upper estuary and a secondary bloom near the point in the River that most of the suspended material settles out. The changes in ammonia and nitrates are highly correlated to the productivity patterns. Phosphorous rates are less closely correlated to productivity. The perturbations that the Chalk Point steam electric power plant have on the heat and oxygen balances are easily discernible. References (11 items).

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A numerical wave refraction and shoaling analysis was conducted to transfer wave hindcast data from deep water to the entrance of Tillamook Bay. Also included was a general description of the transformation of surface gravity wave in shoaling water and the effect of tidal currents on gravity wave. No specific conclusions were required of the study but the data was used by the Portland District and North Pacific Division to access navigation hazards at the entrance between the existing north jetty and the proposed south jetty extension. (Author.)

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U.S. Army Engineer Waterways Experiment Station. Westport Small-Boat Basin Revision Study; Hydraulic Model Investigation, by N.J. Brogdon, Jr. Miscellaneous Paper H-75-8, November 1975. (See annotation in Section VI.)

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Van de Kreeke, J. Increasing the Mean Current in Coastal Channels. Journal of the Waterways, Harbors and Coastal Engineering Division, Proc. ASCE, vol.102, No.WW2, p.223-234, May 1976.

Results of previously published theoretical studies suggest that properly designed inlets and channel constrictions, or both, can considerably increase the mean current in coastal channels. This

was further investigated by laboratory experiments in a channel of uniform width and depth at each end connected to the same tidal basin. A mean current was induced by providing one end of the channel with a constriction in the form of a submerged weir. Measured values for the mean current were in good agreement with values obtained by numerical integration of the governing hydrodynamic equations. For each experiment the direction of the mean current was the same for each point in the vertical. The direction of the mean current was not the same for all experiments. To aid in the interpretation of the results an approximate analytic expression for the mean current was derived. References (8 items).

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It follows from measurements that advection is the dominant mode of transport in the Marco River. Typical values for the tidally averaged salt and water flux are respectively 400 kg s^{-1} and 20 m^3 s^{-1}. An analysis of the dynamics of the flow shows that the longitudinal flux of water is associated with the tidal stress, the tidally averaged bottom stress, the spatial variation of the mean water level and the cross-sectionally averaged salinity. An approximate analytic expression is derived to illustrate the independent effects of the differences in tidal amplitude, phase, mean water level and density at the open boundaries on the net flux of water. Using a finite difference technique, the magnitude of the tidally averaged water flux and its components associated with the Eulerian mean velocity and Stokes Drift velocity are computed for two schematizations of the Marco River. Computed and measured quantities are in fair agreement. References (7 items).

Van de Kreeke, J. Tide-Induced Mass Transport; A Flushing Mechanism for Shallow Lagoons. JOURNAL OF HYDRAULIC RESEARCH, vol.14, No.1, p.61-67, 1976.

Based on the one-dimensional long wave equations a discussion of the physics underlying the tide-induced mass transport in lagoons is presented. It follows from the dynamic equation that the bottom stress associated with the mass transport serves to balance the gradient of the radiation stress and the net bottom stress associated with the (tidal) waves. The mass transport is at best of $o(a/h)$ (a = tidal amplitude, h = depth). It is shown that inlets can play an important role in the mass transport and that by properly selecting the inlet dimensions that mass transport can be considerably increased. Numerically computed values show that the tide-induced mass transport can be an important mechanism in renewing the waters of shallow lagoons. References (5 items).

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The tide-induced mass transport in a lagoon connected to the ocean by more than one opening is examined. An analysis of the dynamics of the water motion reveals that the bottom stress associated with the mass transport serves to balance the gradient of the excess momentum flux across the vertical and the net bottom stress associated with the (tidal) wave motion. From kinematic considerations it follows that the mass transport divided by the depth is the equivalent of the Lagrangian mean velocity. The effect of inlets on the mass transport is discussed. It is shown that for shallow lagoons the tide-induced mass transport can be an important flushing mechanism. References (5 items).

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This paper examines the tide-induced net discharge in lagoon-inlet systems. In particular, attention is given to the role inlets play in inducing a steady current. The flow in the lagoon is described by the one-dimensional long wave equations, the flow in the inlets is described by a semi-empirical equation. Both numerical and analytical techniques are employed to solve for the net discharge. The results of the study indicate that 1) the net discharge can be significant provided the tidal amplitude to depth ratio is not small 2) the net discharge can be considerably increased by the proper selection of the inlet dimensions. References (8 items).

Van de Kreeke, J., and Dean, R.G. Tide-Induced Mass Transport in Lagoons. Journal of the Waterways, Harbors and Coastal Engineering Division, Proc. ASCE, vol. 101, No.WW4, p.393-403, November 1975.

This paper examines the tide-induced mass transport in coastal lagoons which are connected to the ocean by more than one opening. An approximate analytic expression for the tide-induced mass transport in a lagoon of uniform width and depth at each end freely connected to a tidal basin is derived, assuming one-dimensional homogeneous flow. Analytic results are compared with numerically computed values of the mass transport. It is shown that the tide-induced mass transport can be an important factor in the renewal of the waters of shallow lagoons. References (12 items).

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Measurements of waves and currents at one location in Southampton Water show considerable increase in the wave energy when the tide begins to ebb. Some of the theoretical changes in the form of wind-generated waves in estuaries can be simply described using non-time varying currents. With the addition of time variation it is shown that numerical techniques offer a useful method for determining theoretically the changes in the wave energy and wavenumber of waves interacting with tidal currents. The trends in the variation of wave energy with current speed of the observed data and the numerical model are shown to be in broad agreement but that the considerable variability between consecutive spectra of the Southampton Water data require further explanation. References (12 items).

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Ward, G.H. Formulation and Closure of a Model of Tidal-Mean Circulation in a Stratified Estuary. Estuarine Processes; Volume II, Circulation, Sediments, and Transfer of Material in the Estuary, edited by Martin Wiley. New York, Academic Press, 1977, p.365-378. (See annotation in Section VI.)

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Measurements of the dispersion of dye clouds from point sources were made in the Fraser estuary located in British Columbia. These studies were partly instigated by the installation of a major treated sewage outfall (7) in the estuary at a point 12.5 miles (20 km) from the mouth. References (10 items).

Ward, P.R.B. The Transverse Distribution of Velocity in Estuary Flow. JOURNAL OF HYDRAULIC RESEARCH, vol.12, No.2, p.253-274, 1974.

Homogeneous estuary flows and tidal models of estuaries are known to exhibit a phase shift effect. The velocity versus time curves from various positions in the transverse, z, direction (perpendicular to the long axis) may be shifted relative to one another by times of as much as 1 hour. An explanation of this phase shift is presented in terms of the magnitude of the relevant forces. A Strouhal number, proportional to fu_oT/d, where f is the friction factor, u_o is the longitudinal velocity, T is the tidal period and d is the depth of flow, is shown to be important in describing the amount of phase shift. Two situations which result in horizontal phase differences are analyzed, and laboratory measurements of both cases are presented. In one case the phase difference results from a slow variation of depth with position z, and in the second case the phase shift results from the influence of very large sidewall roughness in a deep channel. References (11 items).

Warme, J.E., Sanchez-Barreda, L.A., and Biddle, K.T. Sedimentary Patterns and Processes in West Coast Lagoons. Estuarine Processes; Volume II, Circulation, Sediments, and Transfer of Material in the Estuary, edited by Martin Wiley. New York, Academic Press, 1977, p.167-181. (See annotation in Section II.)

Washington University, Division of Marine Resources. Tide Prints: Surface Tidal Currents in Puget Sound, by N. McGary and J.H. Lincoln. Washington Sea Grant Publication WSG-77-1, January 1977. (See annotation in Section VIII.)

Weisberg, R.H. The Nontidal Flow in the Providence River of Narragansett Bay: A Stochastic Approach to Estuarine Circulation. JOURNAL OF PHYSICAL OCEANOGRAPHY, vol.6, No.5, p.721-734, September 1976. (See annotation in Section VI.)

Weisberg, R.H. A Note on Estuarine Mean Flow Estimation. JOURNAL OF MARINE RESEARCH, vol.34, No.3, p.387-394, August 1976. (See annotation in Section VII.)

Weisberg, R.H., and Sturges, W. Velocity Observations in the West Passage of Narragansett Bay: A Partially Mixed Estuary. JOURNAL OF PHYSICAL OCEANOGRAPHY, vol.6, No.3, p.345-354, May 1976. (See annotation in Section VIII.)

Welander, P. Two-Layer Exchange in an Estuary Basin, with Special Reference to the Baltic Sea. JOURNAL OF PHYSICAL OCEANOGRAPHY, vol.4, No.4, p.542-556, October 1974.

Stationary and transient states of a two-layer fjord-type estuary are discussed analytically. The forcing functions are the outer salinity S_o, the fresh-water supply q_f, and a meteorologically forced barotropic transport q_m. Forced non-linear, time-dependent cases have been studied numerically. Some associated laboratory experiments are described. The main results obtained are as follows: (i) A single steady state exists; this is approached in an exponential-like way. (ii) The total mixing through the interface must vary with depth (decrease for increasing interface depth) to allow a stable steady state. (iii) The static stability increases with increasing fresh-water supply, up to a critical value where the two-layer model breaks down. (iv) An added oscillatory component in S_o increases and in q_f decreases the estuary salinity and the static stability. The effect of an oscillatory q_m may go in either direction. (v) The statistical steady state is sensitive to certain high-order statistical features, of the forcing functions. It is suggested that changes in such statistical features, rather than changes in mean forcing conditions, may explain observed physical-chemical secular variations in the Baltic, in particular the drop of oxygen concentrations of the deep water. References (8 items).

West, J.R. Water Movements in the Tay Estuary. The Royal Society of Edinburgh, Proceedings, Section B, vol.71, Parts 2/4, p.115-129, 1972.

The present poor understanding of the fundamental mechanisms of estuarine water movement necessitates an empirical or semi-empirical approach to the circulation problem. The Tay estuary may be considered as a system for which the inputs consist of phenomena of marine and fluvial origin, and the output is the resultant fluid motion. The definition of the boundaries of the system and of the inputs is explained. The functional dependence of fluid motion is examined with respect to the existing knowledge of estuarine circulation and the economic and technological difficulties associated with prototype estuarine investigations. The results of these studies formed the basis for planning a field study of the Tay estuary. Data collected during the year 1969-70 have permitted the formulation of empirical relationships between parametric forms of the input and output variables. Thus, to a first approximation, the parameters of estuarine water motion can be predicted for particular antecedent input conditions. References to Literature (12 items).

West, J.R., and Williams, D.J.A. Some Basic Problems of Estuarine Water Quality Control. In Statistical and Mathematical Aspects of Pollution Problems, edited by John W. Pratt; Marcel Dekker, Inc., New York, 1974, Part III, Chapter 13 (p.193-212).

The use of statistics is demonstrated for two water quality control problems. Essentially the first used temporal and spatial averaging techniques in order to quantify, through analysis of field data, the effects of small fluctuations in velocity and salinity, which are at present very difficult to measure. The second problem illustrates the use of a simple statistical model to make possible the parametric representation of a record which is subject to apparently random fluctuations and appreciable experimental error. The use of these techniques is essential, with existing measurement techniques, if spatially and temporally dependent estuarine phenomena are to be quantified. Such a treatment of instantaneous point values of salinity permits the effects of a number of complex phenomena, generally called turbulent mixing or diffusion, to be evaluated in the form of a coefficient. Studies of less readily measured variables, e.g., bacterial levels, are dependent on such techniques. References (14 items).

Western Canada Hydraulic Laboratories, Ltd., Port Coquitlam, B.C. Final Report - Phase I Studies on Flushing of Small Harbours. Department of the Environment, Small Craft Harbours Branch, Pacific Region, Vancouver, B.C., March 1977. (See annotation in Section VII.)

Weston, A.E. The Measurement of Interactive Freshwater and Tidal Flows in the River Dee, North Wales. JOURNAL OF THE INSTITUTION OF WATER ENGINEERS AND

SCIENTISTS, vol.33, No.1, p.69-79, January 1979.

Traditionally, the lower reaches of a major river system have proved the most intractable in attempting to understand the complex inter-relationship between tides, freshwater flow, and water quality conditions. The river Dee, in North Wales, is no exception. The area of interaction between tides and freshwater flows ranges from Hilbre Island, at the mouth of the Dee Estuary, to Pickhill, 70 km inland and 30 km upstream of the ancient weir at Chester, which greatly influences the hydraulics of the reach. Freshwater flows down the Dee would normally vary naturally between 2 and 180 m^3/sec, and tide levels at Liverpool (equivalent to the mouth of the estuary) vary from 6.24 m AOD Newlyn (at a return period of 1 in 100 years) to 1.60 m AOD Newlyn at neap tides. The Dee, being a regulated river, supports continuous abstractions by statutory water undertakings of 6 m^3/sec at present from the lower reaches upstream of Chester Weir. This will rise to 8.5 m^3/sec by the early 1980s, making the Dee the largest single source of potable water in Wales or Northern England. In addition, industrial abstractions of 4.5 m^3/sec take place from the estuary for the British Steel Corporation and the CEGB downstream of Chester Weir. In such circumstances, even without the interest in a Dee Estuary Scheme in recent years, a basic understanding of the hydraulics of the lower and tidal Dee is obviously essential. This paper discusses the development of operational systems needed to forecast tidal peaks, tidal affected river levels, and saline intrusions from a series of relatively simple hydrometric and chemical measurements. Although there is considerable scope for the extension of this work into a computer-based mathematical modelling system, the value of accurate basic measurements, interpreted rationally and presented concisely, should not be under-estimated.

Whipple, W., Jr., Hunter, J.V., Ahlert, R.C., et al. Estimating Runoff Pollution from Large Urban Areas--The Delaware Estuary. New Brunswick, N.J., Rutgers University, Water Resources Research Institute, July 1978. (See annotation in Section IV.)

Whipple, W., Jr., Hunter, J.V., Dittman, F.W., et al. Oxygen Regeneration of Polluted Rivers: The Delaware River. Environmental Protection Agency, Water Quality Office, Program No.16080 DUP, December 1970. (See annotation in Section IV.)

Whipple, W., Jr., Hunter, J.V., Dittman, F.W., et al. Oxygen Regeneration of Polluted Rivers: The Passaic River. Water Resources Research Institute, Rutgers University, New Brunswick, N.J., Water Pollution Control Research Series, 16080 FYA 03/71. (See annotation in Section IV.)

White, F.M., Lessmann, R.C., and Spaulding, M.L. Numerical Estuarine Models for Water Quality Management in the Blackstone River-Providence River and the Taunton River-Mt. Hope Bay Complexes. Rhode Island Water Resources Center, Completion Report, OWRR Project A-059-RI, June 30, 1976. (See annotation in Section VI.)

Williams, B.J., and Hinwood, J.B. On the Development and Calibration of a Large Numerical Hydrodynamic Model. Fifth Australasian Conference on Hydraulics and Fluid Mechanics, University of Canterbury, Christchurch, New Zealand, 9-13 December 1974; Conference Proceedings, vol.II, p.244-249. (See annotation in Section VI.)

Williams, D.J.A., and West, J.R. Salinity Distribution in the Tay Estuary. The Royal Society of Edinburgh, Proceedings, Section B, vol.75, Parts 1/2, p.29-39, 1975. (See annotation in Section III.)

Wilson, R.E. Gravitational Circulation in Long Island Sound. ESTUARINE AND COASTAL MARINE SCIENCE, vol.4, No.4, p.443-453, July 1976.

Long Island Sound has some important estuarine characteristics including tidal motions transmitted from the sea and a dilution of seawater with fresh-water. Longitudinal salinity and associated density gradients exist in the Sound throughout the year and maintain non-tidal two-layer gravitational circulation. The volume transport due to this circulation has been determined from simple dynamic computations based on a force balance between the vertical gradient of the turbulent stress resulting from tidal motions and the pressure gradient resulting from horizontal density variations. Data from four hydrographic cruises conducted in the Sound by Marine Sciences Research Center were used to evaluate the horizontal pressure gradient. The transport computations indicate that gravitational circulation is

well-developed in the western and central Sound and intense in the eastern Sound. References (16 items).

Wing, R.H., Editor. A Test Particle Dispersion Study in Massachusetts Bay. U.S. National Oceanic and Atmospheric Administration, NOAA Technical Report ERL 374-MESA 6, September 1976. (See annotation in Section VII.)

Winter, D.F. A Similarity Solution for Circulation in Stratified Fjords. International Symposium on Stratified Flows, Novosibirsk (U.S.S.R.), 1972, Communication 29.

Symposium sponsored by the International Association for Hydraulic Research and the Academy of Sciences of the U.S.S.R. Stratified estuaries with relatively deep, laterally constricted basins are commonly referred to as fjords. It is characteristic of fjords which receive fresh-water runoff that the most vigorous circulation takes place near the surface in a backish phase with one or two current reversals. This paper is concerned with the analysis of a steady-state circulation with a single current reversal in the absence of wind stress. The upper zone or "layer," as it is referred to in the text, moves persistently seaward above a landward-moving deeper layer of denser, more saline water which is ultimately supplied to the basin by the sea. Approximate analytic expressions are obtained for the velocity components and the density distribution in a fjord segment where conditions for a similarity analysis are satisfied. The method is illustrated by application to Knight Inlet on the mainland coast of British Columbia, Canada. Comparisons of measured and computed salinity profiles show that the density structure is well represented by the approximate solution. It is also shown that the computed horizontal velocity profile is in fair agreement with measured current profiles in the inlet segment. The flow description given here may be of direct utility in studies of pollutant dispersal and biological production in fjords. References (9 items).

Winter, D.F. Studies of Circulation and Primary Production in Deep Inlet Environments. U.S. Environmental Protection Agency, EPA-600/3-77-049, April 1977.

The report summarizes the results of a three-year grant from the U.S. Environmental Protection Agency to investigate various aspects of circulation dynamics and primary production in a deep inlet environment. Throughout the course of the research, special attention has been given to Puget Sound, Washington, although many of the findings are applicable to other deep inlet waters. The several tasks undertaken during the course of the project fall into three general categories: (1) Numerical modeling of gravitational convection and tidal motions in deep estuaries; (2) Hydraulic model studies of tidal circulation patterns and dye dispersal characteristics in Puget Sound; and (3) Numerical modeling of primary production in a deep inlet (in particular, the deep central basin of Puget Sound). References (21 items).

Wolanski, E.J., and Banner, M.L. Buoyant Surface Jets in Tidal Longshore Currents. Journal of the Hydraulics Division, Proceedings, ASCE, vol.104, No.HY11, p.1505-1519, November 1978. (See annotation in Section VI.)

Wood, E.F., Harley, B.M., and Perkins, F.E. Transient Flow Routing in Channel Networks. WATER RESOURCES RESEARCH, vol.11, No.3, p.423-430, June 1975. (See annotation in Section VI.)

Wood, F.J. The Strategic Role of Perigean Spring Tides in Nautical History and North American Coastal Flooding, 1935-1976. Washington, U.S. National Oceanic and Atmospheric Administration, 1978.

A definitive study of the origin, nature, and impact of severe tidal flooding of lowland coastal regions caused by a combination of astronomical and meteorological forces. The publication documents more than a hundred major coastal flooding events and discusses related hazards to maritime commerce, seashore communities, and the coastal environment. The historical, practical, and environmental aspects of perigean spring tides are discussed in the book, as well as historical events that were influenced by perigean spring tides. Such exceptionally high tides and their accelerated ocean currents, along with high seasurface winds have caused extensive flooding of coastal areas in the past. Perigean spring tides occur when the moon and sun are in alignment and the moon is at its closest point to the earth. The term "spring" has nothing to do with the season of the year in which these tides take place. Among the events documented and discussed in the publication are: correlations between more than 100 cases of major tidal flooding and the coincident existence of perigean spring tides; discussions of representative cases of perigean spring tides which have altered the course of

naval history; evaluation of the practical impact of perigean spring tides on coastal and inshore navigation, marine engineering, hydrological runoff, bioecological imbalance, and erosional damage to the coastal environment; and examination of various instances of ship groundings, strandings, and collisions caused by the effects of perigean spring tides.

Wright, F.F. Estuarine Oceanography. McGraw-Hill Book Company, New York, St. Louis, etc., 1974. American Geological Institute, Council on Education in the Geological Sciences, CEGS Programs Publication Number 18. 76p. (See annotation in Section VII.)

Yalin, M.S., and Price, W.A. Formation of Dunes by Tidal Flows. Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, Copenhagen, Denmark, vol.II, 1975, Chapter 57 (p.991-1008). (See annotation in Section II.)

Yalin, M.S., and Price, W.A. Time Growth of Tidal Dunes in a Physical Model. Symposium on Modeling Techniques, 2nd Annual Symposium of the Waterways, Harbors and Coastal Engineering Division of ASCE, San Francisco, California, September 3-5, 1975, vol.II, p.936-944. (See annotation in Section VI.)

Yi, S.-U. On Tides, Tidal Currents and Tidal Prisms at Inchon Harbour. Journal of the Oceanological Society, Korea, vol.7, No.2, p.86-97, December 1972. (In Korean.)

The tides, tidal currents and tidal prisms at Inchon Harbour were studied with recent data. The tides at Inchon Harbour are of semi-diurnal type having a spring range of 798 cm and a phase age of 2 days. The monthly mean sea level at Inchon has a maximum at August and a minimum at January with an annual range of about 40 cm. The tide currents at Inchon Outer Harbour are of semi-diurnal type same as tides and nearly reversing type. The flood and ebb currents set north and south with a velocity of about 90 ~ 175 cm/sec and 120 ~ 225 cm/sec at spring tide and begin 0.2 hours after L.W. and 0.7 hours after H.W., respectively. Non-tidal currents flow southward with 10 ~ 20 cm/sec at west side of the stream and northward with 15 ~ 20 cm/sec at east side of the stream at Inchon Outer Harbour. The flood volume through the Inchon Outer Harbour fluctuates fort-nightly from 590×10^6 m^3 spring tide to 260×10^6 m^3 at neap tide and ebb volume changes from 470×10^6 m^3 at spring tide to 200×10^6 m^3 at neap tide, respectively. The flow area along the channel to the Estuary of Yeomha is controlled by the tidal prism as expressed by $A = 1.14 \times 10^{-4} P^{0.966}$.

Zimmerman, J.T.F. Dispersion by Tide-Induced Current Vortices. Hydrodynamics of Estuaries and Fjords; Proceedings of the 9th Liege Colloquium on Ocean Hydrodynamics, 1977, p.207-216.

It is shown that the nonlinear interactions of a tidal wave propagating over a complicated bottom topography produce a time-independent residual current velocity field which is a quasi-random function of space. The superposition of this Eulerian residual velocity field and the oscillatory tidal current gives rise to a dispersion process in the Lagrangian sense, the "diffusion coefficient" of which is related to the relevant parameters of both Eulerian components of the total velocity field. For diffusion time intervals small as compared with the Lagrangian velocity correlation time-scale, it appears that the gross transport of dissolved substances in a tidal channel should be described by the telegraph equation which takes into account the finiteness of the random Lagrangian particle velocities. References (11 items).

Zvirin, Y., and Shinnar, R. A Comparison of Lumped-Parameter and Diffusional Models Describing the Effects of the Outlet Boundary Conditions on the Mixing in Flow Systems. WATER RESEARCH, vol.10, No.9, p.765-779, 1976. (See annotation in Section VI.)

SECTION II. SEDIMENTATION

Sources, identification, transportation, deposition, flocculation, and physical and chemical properties of sediment found in tidal waterways. The upland river is excluded unless specifically concerned as a source and agent of transport of tidal sediment.

Ahr, W.M., Daubenspeck, J., Harry, H.W., et al. Resource Evaluation Studies on the Matagorda Bay Area, Texas. Texas A&M University, Sea Grant College, TAMU-SG-74-204, September 1973. (See annotation in Section I.)

Alexander, V., Burrell, D.C., Chang, J., et al. Environmental Studies of an Arctic Estuarine System - Final Report. Institute of Marine Science, University of Alaska, Fairbanks, EPA-660/3-75-026, June 1975. (See annotation in Section VII.)

Allen, G.P. Relationship Between Grain Size Parameter Distribution and Current Patterns in the Gironde Estuary (France). JOURNAL OF SEDIMENTARY PETROLOGY, vol.41, No.1, p.74-88, March 1971.

The bottom sediments in the marine portion of the Gironde estuary have been extensively sampled and studied in relationship to the local wave and tidal current patterns. A semi-empirical analysis was conducted to delimit the areas of wave refraction and the bottom orbital velocity variations. Compilation of the current and wave energy data from on-site measurements shows that distinct energy zones exist, each characterized by different current strength and type. These zones are controlled by the morphological features of the estuary, the tidal and wave energy zones being mutually exclusive. Most of the tidal current discharge occurs in the deeper channels, whereas the shoal areas are the site of important wave energy. Most of the sediments are sands (phi mean between 2.0 and 0.5). A large gravel deposit however was observed at the entrance of the estuary. The textural parameter distribution patterns of the sands coincide with and reflect the different energy zones. The distinct combination of energy type in a particular zone will cause a distinct textural pattern in the sediments found within it. Moreover, comparison of the time-averaged tidal velocities with standard sediment erosion curves shows that the grain size distribution of the sands seems to be in equilibrium with the hydraulic environment. The gravel deposit is inferred to be a fossil alluvial terrace because it does not seem to be in accord with the present-day current patterns. A marked functionality exists between the more significant parameters of size, sorting and skewness and the ratio of wave to tidal energy. This is particularly evident in parameter distribution maps. The mean grain size, sorting, and skewness of the sands are inversely proportional to the ratio of wave to tidal activity. The inferred transportational processes seem also to reflect the established energy zones. A CM curve analysis indicates a graded suspension transport mode for zones where wave energy predominates, and bedload transport for areas influenced by tidal currents. This effect seems to be corroborated by consideration of the orbital bottom wave velocity as a function of depth. The depth limit for the transportational processes due to wave activity seems to be about 15 meters. Beyond this depth, the sediment is transported mainly by the tidal currents. It is concluded that textural patterns are good indicators of energy variations, even in complex, multi-environmental areas such as estuaries. Future research will probably establish quantitative relationships between energy type and distribution and the resulting textural parameters. References (43 items).

Allen, G.P., Bonnefille, R., Courtois, G., et al. Processus de sédimentation des vases dans l'estuaire de la Gironde. Contribution d'un traceur radio-actif pour l'étude du déplacement des vases (Sediment Drift and Accumulation Processes in the Gironde Estuary. Contribution of a Radioactive Tracer to the Study of Mud Displacement). LA HOUILLE BLANCHE, vol.29, No.1/2, p.129-136, 1974. (In French.)

Sedimentation taking place in the Gironde estuary is related to inter-action between river flow and tides in the form of salt water intrusion and the vertical distribution of residual current circulation, resulting in the formation of a "mud plug," i.e. a sediment settling area with seasonal positional variations. Off the estuary, sand movement follows a wide circulation path as a result of tidal currents and waves. Bibliography (11 items). With discussion.

Allen, G.P., Sauzay, G., Castaing, P., et al. Transport and Deposition of Suspended Sediment in the Gironde Estuary, France. Estuarine Processes; Volume II, Circulation, Sediments, and Transfer of Material in the Estuary, edited by Martin Wiley. New York, Academic Press, 1977, p.63-81.

A highly concentrated (1-10 g/l) turbidity maximum develops at the upstream limit of the salinity intrusion in the Gironde estuary, nourished by the large seasonal influx of alluvial suspended sediment. The estuary contains two distinct channel systems. In the deeper southern channel, a marked tidal cycle occurs: during neap tides, fluid mud accumulates from settling in the core of

the turbidity maximum; during spring tides it is eroded and resuspended. The maximum and fluid mud undergo a seasonal upstream-downstream migration in response to varying river discharge. These phenomena have been studied using hydrological and radioactive tracer techniques. Very little movement and diffusion occurs within the fluid mud. At each cycle of accumulation and resuspension, a residual lamination is deposited in the channel. During high river flow the resuspended mud is transported by lateral advection to the north channel, where part settles out, and part is evacuated out to sea. This lateral migration and seaward escape appear to be amplified by dredging. Sediment renewal in the fluid mud-turbidity maximum system appears to be related to its position in the estuary; downstream, lateral losses induce a rapid turnover; upstream, it behaves more like a closed system, with internal recycling. References (11 items).

Amos, C.L., and Collins, M.B. The Combined Effects of Wave Motion and Tidal Currents on the Morphology of Intertidal Ripple Marks: The Wash, U.K. JOURNAL OF SEDIMENTARY PETROLOGY, vol.48, No.3, p.849-856, September 1978.

A simple method is presented of applying synoptic wave and current data, collected within the natural environment, to the generation of intertidal ripple marks. Initially data was collected during two summer seasons across an intertidal sand flat of The Wash, Lincolnshire, U.K. The bedforms, interpreted on the basis of morphology, were considered current formed on the lower sand flat, intermediate on the middle sand flat, and wave formed on the inner sand flat. The limits in the spatial occurrence of these variously formed ripples were then related to a computed dimensionless ratio of wave and tidal flows at the bed. Results indicate that at ratios greater than approximately 10, wave-generated ripples occurred, below a ratio of 1 current-generated ripples predominated, and between these values an intermediate ripple type was generated. Computation of ratios of various stages of the tide gives an indication of the type of bedform to be occurring on the bed at that time. References (27 items).

Anderson, F.E. The Effect of Boat Waves on the Sedimentary Processes of a New England Tidal Flat. University of New Hampshire, Department of Earth Sciences and Jackson Estuarine Laboratory, Durham, Technical Report, 1 February 1974.

In order to estimate the effect of increased boat traffic on channel bank and tidal flat erosion, a system of intake valves was "plumbed" into a portion of a tidal flat in the Great Bay Estuary of New Hampshire. Waves were set up from six different boats, ranging in size from 13 to 34 ft. Water samples were collected from 8 stations orthogonally spaced over the tidal flat. At each station, water samples at 30 and 15 cm off the bottom were collected before, during and after the boat wave passed by and filtered for total suspended load. The boat wave characteristics were measured, along with the bottom currents, salinity, near bottom temperatures, and temperature profiles of the water column. Boat waves were set up at the beginning of the flood phase and near the end of the ebb. These waves were set up at the same water depth for each phase of the tide. The study indicates that the boat waves can resuspend 1/3 to 1/2 more sediments under the same wave conditions on the flood tide than on the ebb tide. In this case, during the flood tide the resuspended sediments were transported seaward in a tidal current gyre in the sampling area. There is a possibility that density underflows may form under severe wave activity and cause additional seaward transportation. The horizontal bottom velocities, calculated from the boat wave characteristics as low as 15 cm/sec, were able to resuspend fine-grained estuarine sediments. References Cited (19 items).

Ariathurai, C.R. A Finite Element Model for Sediment Transport in Estuaries. Dissertation, Ph.D. in Engineering, University of California at Davis, 1974. (See annotation in Section VI.)

Ariathurai, R., and Krone, R.B. Finite Element Model for Cohesive Sediment Transport. Journal of the Hydraulics Division, Proc. ASCE, vol.102, No.HY3, p.323-338, March 1976. (See annotation in Section VI.)

Ariathurai, R., and Krone, R.B. Mathematical Modeling of Sediment Transport in Estuaries. Estuarine Processes; Volume II, Circulation, Sediments, and Transfer of Material in the Estuary, edited by Martin Wiley. New York, Academic Press, 1977, p.98-106. (See annotation in Section VI.)

Barwis, J.H. Annotated Bibliography on the Geologic, Hydraulic, and Engineering Aspects of Tidal Inlets. U.S. Army

Corps of Engineers, General Investigation of Tidal Inlets, GITI Report 4, January 1976.

A program of research conducted jointly by U.S. Army Coastal Engineering Research Center, Fort Belvoir, Virginia, and U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Abstracts and annotations are given for about 1000 published and unpublished reports, dated 1973 and earlier, on the geologic and engineering aspects of tidal inlets. Insofar as they relate to inlets, references are given on tidal hydraulics, engineering structures, littoral processes, stratigraphy and geologic history, coastal aerial photography, and Corps of Engineers reports of investigation of individual inlets.

Barwis, J.H. Catalog of Tidal Inlet Aerial Photography. U.S. Army Corps of Engineers, General Investigation of Tidal Inlets, GITI Report 75-2, June 1975. (See annotation in Section VIII.)

Bastin, A. Natural Radioactive Tracers and Their Use in Belgium: Lithological Maps of the Bottom of the North Sea Off the Belgian Coast and of the Scheldt Estuary Constructed on the Basis of Natural Radioactivity Measurements. Paper presented at a panel meeting on the Use of Tracers in Sedimentology, held at the Centre d'Etudes Nucleaires de Saclay, 21-25 June 1971. In: Tracer Techniques in Sediment Transport, International Atomic Energy Agency, Vienna, Technical Report Series No.145, p.179-200, May 1973. (See annotation in Section VII.)

Bellessort, B. Movement of Suspended Sediments in Estuaries: Flocculation and Rate of Removal of Muddy Sediments. Paper presented at a panel meeting on the Use of Tracers in Sedimentology, held at the Centre d'Etudes Nucleaires de Saclay, 21-25 June 1971. In: Tracer Techniques in Sediment Transport, International Atomic Energy Agency, Vienna, Technical Report Series No.145, p.31-40, May 1973.

In estuaries, the movement of mud is an economic problem of particular importance since it has a bearing on the maintenance of access channels to harbors. It is a particularly critical problem to tackle since mud movement depends on many parameters which as yet are not well known. The first part of this chapter discusses the main factors governing the dynamics of estuaries, and the second part deals more specifically with the problems of flocculation and removal rate of cohesive sediments. (From paper.)

Bellis, V., O'Connor, M.P., and Riggs, S.R. Estuarine Shoreline Erosion in the Albemarle-Pamlico Region of North Carolina. North Carolina State University, Raleigh, UNC Sea Grant Publication UNC-SG-75-29, December 1975.

Shoreline erosion within the estuaries of North Carolina is a continuing process which has been in operation for several thousand years. Actual rates of erosion range up to twenty feet per year but average 2-3 feet per year. Variables affecting rate of shoreline erosion are: bank height and composition, vegetative cover, exposure to prevailing winds and fetch, offshore topography, and various human activities. Three major shoreline types are identified on the basis of these parameters. These are: 1) Sand and Clay Banks, 2) Swamp Forest, and 3) Grass Marsh. Of these shoreline types only the sand and clay banks can be easily developed. All types, however, can be protected by shoreline modification structures, utilization of natural protective features, or appropriate setback regulations. References (15 items).

Benedict, P.C. Equipment for Investigations of Fluvial Sediment. Journal of the Hydraulics Division, ASCE, vol.105, No.HY3, p.163-170, March 1979. (See annotation in Section VII.)

Benninger, L.K. The Uranium-Series Radionuclides as Tracers of Geochemical Processes in Long Island Sound. Dissertation, Ph.D, Yale University, May 1976.

An estuary can be visualized as a membrane between land and the deep ocean, and the understanding of the estuarine processes which determine the permeability of this membrane to terrigenous materials is necessary for the estimation of fluxes of these materials to the oceans. Natural radionuclides are useful probes into estuarine geochemistry because of the time-dependent relationships among them and because, as analogs of stable elements, they are much less subject to contamination during sampling and analysis. In this study the flux of heavy metals through Long Island Sound is considered in light of the material balance for excess ^{210}Pb, and analyses of concurrent seston and water samples from central Long Island Sound are used to probe the internal workings of the estuary. References (145 items).

Besnier, G., and Leroy, E. L'aménagement des estuaires de la Vilaine et du Lay (Development of the Vilaine and Lay

Estuaries). LA HOUILLE BLANCHE, vol.29, No.1/2, p.91-102, 1974. (In French.)

Flocculation of sediment drifting down from upstream has often been held responsible for the silting-up of estuaries. However, development work on the Lay and Vilaine estuaries has brought different forms of sediment behavior to light. Since the closure of the Vilaine estuary at the end of 1970, the work done has shown itself to have been effective in attenuating floods (i.e. reducing the flood threat to riverside communities), completely stopping silting both upstream and downstream, and providing a fresh water network solving the supply problem for a densely populated region with few natural resources. In addition, the scheme has considerably enchanced the area's potential for tourism. With discussion.

Billen, G., and Smitz, J. Mathematical Model of Water Quality in a Highly Polluted Estuary. Hydrodynamics of Estuaries and Fjords; Proceedings of the 9th Liege Colloquium on Ocean Hydrodynamics, 1977, p.55-62. (See annotation in Section VI.)

Bohlen, W.F. An Investigation of Turbidity in Estuarine Waters. The University of Connecticut, Research Project Technical Completion Report, November 6, 1974. NTIS Report PB-238 315.

The relationship between total turbidity and its component parts is investigated within the Connecticut River estuary and adjacent Long Island Sound. Analyses of more than 200 drawn water samples obtained at a network of 11 stations over two years provide a detailed description of the spatial and temporal distribution of total suspended solids and the relative fraction of dissolved and suspended organic and inorganic constituents. These data correlate with bulk turbidity characteristics and selected water quality parameters, including DO, BOD, and coliform bacteria counts. List of Publications (3 items).

Bohlen, W.F. Shear Stress and Sediment Transport in Unsteady Turbulent Flows. Estuarine Processes; Volume II, Circulation, Sediments, and Transfer of Material in the Estuary, edited by Martin Wiley. New York, Academic Press, 1977. p.109-123. (See annotation in Section VIII.)

Bokuniewicz, H.J. Estuarine Sediment Flux Evaluated in Long Island Sound. Ph.D. Dissertation, Yale University, May 1976.

Energy for sediment transport in an estuary may be supplied by wind-driven or gravity induced circulation, or tidal currents. To evaluate the relative importance of these agents in a large tidal estuary (Long Island Sound), water velocity characteristics 2 m above the bottom were examined for a year at two stations and for shorter periods at 30 additional locations. The observations show that 85% of the energy available for sediment transport is derived from currents flowing at velocities less than the maximum tidal velocity, u_o. Fluctuations in the observed velocity are isotropic and uncorrelated to the phase of the tide. The magnitude of velocity fluctuations increases with increasing wind stress. The mean sediment flux is $\bar{j} \propto \bar{u}(1.5u_o^2 + \bar{u} + 3u'^2)$, where $\bar{u}$ is the mean velocity due primarily to the estuarine circulation in Long Island Sound and u' is the fluctuating velocity component. The magnitudes of the three terms are in a ratio of 10:1:1. For fine sand in Long Island Sound, $\bar{j}$ may be calculated from current observations to be about 0.003 cm^3/cm-sec to the west (inward). Observations of the migration of sand waves in the eastern Sound by repeated bathymetric surveys show the sand flux to be about 0.01 cm^3/cm-sec to the west. For times much longer than the tidal period, the dispersion of sand may be described by a transport equation assuming sand moves in a thin zone at the sediment-water interface by advection and diffusion until removed from the zone and immobilized by the accretion of the bottom. The model is applied to the transport of sand parallel to the current direction from the sandy bottom of the eastern Sound, across a 20 km transition zone, to a silt bottom in the central Sound. The analysis predicts that the sand distribution approaches steady-state in a few decades, and requires the advective sand flux to be 3.5×10^{-3} cm^3/cm-sec, while the diffusive flux is less than 0.6×10^{-3}/cm-sec. Bibliography (96 items).

Bokuniewicz, H.J., Gebert, J., and Gordon, R.B. Sediment Mass Balance of a Large Estuary, Long Island Sound. ESTUARINE AND COASTAL MARINE SCIENCE, vol.4, No.5, p.523-536, September 1976.

Acoustic reflection profiles and bottom sampling are used to measure the volume of sediments accumulated in Long Island Sound. There is present $1.0 \times 10^{10} m^3$ of sediment of which $5.3 \times 10^9 m^3$ is marine mud and $4.9 \times 10^8 m^3$ is probably of

premarine, lacustrine origin. The balance consists of reworked sand derived from glacial drift. The acoustically determined subsurface structure of the Sound and available sea level data indicate that the Sound basin was occupied by a large lake for at least 6000 years and has been an arm of the sea since 8000 years B.P. The volume of lacustrine sediment is accounted for by direct riverine input over 6000 years but the volume of marine mud present substantially exceeds the riverine supply over 8000 years. The Sound is shown to act as a trap for sediments originating on the continental shelf. References (29 items).

Bokuniewicz, H. J., Gordon, R.B., and Pilbeam, C.C. Stress on the Bottom of an Estuary. NATURE, vol.257, p.575-577, October 16, 1975.

Many estuaries are sufficiently deep relative to their maximum fetch that even in severe storms the bottom remains undisturbed by wind-generated waves. Yet observations of sediment transport and of changes in benthic animal populations indicate that agitation of the bottom of deep estuaries is not infrequent. Reports on an analysis of current meter records which shows that such bottom disturbances can arise because wind stress at the surface causes increased turbulence deep in the water column and, consequently, a more frequent occurrence of unusually high velocities near the bottom. References (4 items).

Bonnefille, R., Lepetit, J.P., and Lespine, E. Simulation des depôts de vase dans l'estuaire de la Gironde (Simulation of Silt Deposition in the Gironde Estuary). Proceedings, XVIth Congress of the International Association for Hydraulic Research, São Paulo, Brazil, July 27 to August 1, 1975, vol.1, Paper A24. (In French.)

Silt depositions in Gironde estuary follow a seasonal cycle in connection with the floods of the Garonne and Dordogne Rivers. Measurements and radioactive tracers experiments have shown the movements of the "silty zone" along the estuary. A mathematical model, with two stratified layers, is carried out in order to simulate the phenomenon. Some assumptions are successful to reproduce the seasonal movements of the high concentration of sediments in suspension near the bottom of the estuary. References (7 items).

Boothroyd, J.C., and Hubbard, D.K. Bed Form Development and Distribution Pattern, Parker and Essex Estuaries, Massachusetts. University of Massachusetts, Coastal Research Center, Miscellaneous Paper MP 1-74, February 1974.

Velocity, depth, temperature, grain size, and bed form scale and orientation were measured for complete tidal cycles at 50 stations in two New England estuaries. Scuba observation of bed form change and migration, fathometer profiles, and 700 bed form scale and orientation readings were also carried out. This investigation led to the recognition of a sequence of bed forms based on increasing "flow strength." Bed form type is governed by maximum flood and ebb velocities ($\bar{U}_{max}$) attained at a given locality. Velocity asymmetry and duration are important in determining bed form morphology and amount of crossbedding bimodality. Froude number (Fr) shows good correlation with bed form type only in depths less than 2 meters. In the intertidal and shallow subtidal (<2 meters MLW) zone, sand waves are characterized by $\bar{U}_{max}$ 80 centimeters per second, large velocity assymmetry (Fr = 0.15-0.25), planar cross bedding, little crossbedding bimodality, and dominant flood orientation. Cuspate megaripples are characterized by $\bar{U}_{max}$ 80 centimeters per second, small velocity asymmetry (Fr = 0.25-0.4), festoon crossbedding, high crossbed bimodality, and no dominant orientation. In deep subtidal (>2 meters MLW) areas, sand waves are the principal bed form. They show no dominant orientation. However, where $\bar{U}_{max}$ exceeds 80 centimeters per second, megaripples are superimposed on the sand wave form and crossbedding is complex. Literature Cited (16 items).

Boothroyd, J.C., and Hubbard, D.K. Genesis of Bedforms in Mesotidal Estuaries. In: Estuarine Research, Volume II: Geology and Engineering, edited by L. Eugene Cronin, Academic Press, Inc., New York, 1975, p.217-234.

Velocity, depth, and temperature recorded over complete tidal cycles at 50 stations in two northern New England estuaries, combined with bottom profiles, grain-size analysis, 700 bedform scale and orientation readings, and SCUBA observations of bedform migration, indicate that bedform type is governed by: (a) maximum flood and ebb velocities (U_{max}) attained at a given locality; (b) velocity asymmetry (difference of maximum flood and ebb velocity); (c) velocity duration (time span above a given velocity). In the intertidal and shallow subtidal (<2m MLW) zones of tidal deltas, sand waves are

characterized by U_{max} < 80 cm/sec, large velocity asymmetry, and dominant flood orientation. Cuspate megaripples are characterized by U_{max} > 80 cm/sec, slight velocity asymmetry, and no dominant orientation. In deep subtidal (-2m MLW) areas, sand waves are the principal bedform. Those on flood ramps are similar in morphology and flow characteristics but larger in scale than intertidal forms. Sand waves in ebb channels are characterized by large height and spacing, U_{max} > 80cm/sec, superimposed megaripples, and a dominant ebb orientation. Important topographic forms of a larger scale than bedforms are transverse bars and spill-over lobes. Both occur mainly in intertidal or shallow subtidal areas. References (21 items).

Bowker, D.E., and Witte, W.G. Evaluation of Water Samples Collected During Landsat-1 Overpasses of the Lower Chesapeake Bay Area. Proceedings of the International Conference on Environmental Sensing and Assessment, Las Vegas, Nevada, September 14-19, 1975, vol.I. (See annotation in Section VII.)

Bricker, O.P., III, and Troup, B.N. Sediment-Water Exchange in Chesapeake Bay. In: Estuarine Research, Volume I: Chemistry, Biology, and the Estuarine System, edited by L. Eugene Cronin, Academic Press, Inc., New York, 1975, p.3-27.

In Chesapeake Bay, diagenetic reactions in the sediment-interstitial water environment result in the enrichment of many dissolved species relative to their concentrations in the overlying water. Rapid exchange of dissolved species across the sediment-water interface in response to physical and chemical processes leads to the establishment of strong gradients in these species in the upper meter of the sediment column. In spite of the non-equilibrium nature of the overall system, the concentrations of species that participate in reactions whose time scales are rapid relative to their transport through the system, can be adequately described in terms of equilibrium models. The concentrations of chemically non-reactive dissolved materials and species that are involved in slow reactions relative to movement through the system, must be modeled on the basis of non-equilibrium diffusional transport. References (24 items).

Bruun, P. Stability of Tidal Inlets; Theory and Engineering. New York, Elsevier, 1978. 506p.

The book treats the theoretical and applied aspects of this science from basic coastal geomorphology, hydraulics, wave mechanics, and sediment transport technology, to engineering of tidal entrances, design and improvement of inlet channels and the related subject of the maintenance of these channels. Each section has its own list of references.

Bruun, P., Gerritsen, F., and Bhakta, N.P. Evaluation of Overall Entrance Stability of Tidal Entrances. Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, Copenhagen, Denmark, vol.II, 1975, Chapter 91 (p.1566-1584).

This paper is written in continuation of earlier published material dealing with stability of tidal inlets on littoral drift shores. The experience available at that time was responsible for the introduction of two parameters: $V_{mean\ max}$, defined as the mean max. Velocity in the gorge at spring tide and the Ω/M_{tot} ratio (tidal prism at spring tide divided by material transport to the entrance from the adjoining shores) as the most pertinent parameters for description of overall stability. A more detailed justification for this choice is given in this paper, based on computation of the relative sediment transport at various tidal phases. Examples of earlier date and twelve new examples from India are given. List of References (12 items).

Buller, A.T. Sediments of the Tay Estuary. II. Formation of Ephemeral Zones of High Suspended Sediment Concentrations. The Royal Society of Edinburgh, Proceedings, Section B, vol.75, Parts 1/2, p.65-89, 1975.

During periods of sustained moderate river discharge and quiescent marine conditions little external suspended sediment enters the estuarine circulation of the Tay. That material which is in suspension is largely derived from the estuary margins where tidal currents superimposed by wind-induced waves are competent to resuspend fine material from the surface of the "mud" flats and erode bedded silts from the incised banks of minor channels and runnels draining them. The quantities of this sediment entering the system are largely determined by tidal state and amplitude, as well as wind velocity. References (14 items).

Fuller, A.T., and Green, C.D. The Role of Organic Detritus in the Formation of Distinctive Sandy Tidal Flat Sedimentary

Structures, Tay Estuary, Scotland. ESTUARINE AND COASTAL MARINE SCIENCE, vol.4, No.2, p.115-118, March 1976.

The intermittent deposition, subsequent burial and decomposition of organic detritus along part of the Tay estuary's lower sandy tidal flats produce black peaty-sand layers which crudely resemble sedimentary structures typical of mixed tidal flats. Erosion of some of these peaty layers by lateral creek migration results in the formation of peaty-sand clasts. These are organic-rich equivalents of mud clasts normally found as mud pebbles and conglomerates deposited on the bottoms of mixed tidal flat creeks. References (8 items).

Buller, A.T., and McManus, J. Sediments of the Tay Estuary. I. Bottom Sediments of the Upper and Upper Middle Reaches. The Royal Society of Edinburgh, Proceedings, Section B, vol.75, Parts 1/2, p.41-64, 1975.

A lack of modern river-borne sediment and a steady supply of marine materials have led to the hypothesis that the upper Tay estuary is undergoing an erosive phase counterbalanced by a headward moving sheet of largely marine-derived sand presently occupying the upper-middle estuary. This primal division (based on sediment budget criteria) is also reflected in the bathymetry, distribution of sediment types, and sedimentary structures. The situation of two contrasting "phase zones" juxtaposed within a relatively small area is ideal for an empirical and indirect analysis of the response of a wide variety of sediment types to the gross physical processes acting on them. The analysis takes the form of standard grain-size characterizations using conventional sedimentary statistics, supplemented by adaptations of C-M and QDa-Md diagrams transformed for display on distribution maps. References (46 items).

Buller, A.T., Green, C.D., and McManus, J. Dynamics and Sedimentation: The Tay in Comparison with Other Estuaries. In: Nearshore Sediment Dynamics and Sedimentation; an Interdisciplinary Review, edited by J. Hails and A. Carr; John Wiley & Sons, London, New York, etc., 1975, Chapter 9 (p.201-249).

This paper begins with a brief section on estuarial hydraulics which provides a basis for discussion of estuarine sediment sources and distribution; erosion, transportation and deposition of fine-grained sediment; the formational mechanisms of zones of high suspended sediment concentrations; the threshold of motion of coarse-grained sediment; the genesis and migration of bedforms; general rates of transportation and sediment dispersion by waves. Examples from the Tay estuary, Scotland, are compared and contrasted with, and supplemented by, others from many parts of the world. This review provides a basis which can be used to isolate research topics which require special attention. Criticisms range widely, but two of the most important are (a) that expressions describing the erosion, transportation and deposition of estuarine sediments must accommodate unsteady state non-uniform flow conditions and (b) that knowledge of the mechanics of wave action and sediment entrainment by waves within estuaries is almost non-existent. References: p.244-249.

Byrne, R.J., Bullock, P., and Tyler, D.G. Response Characteristics of a Tidal Inlet: A Case Study. In: Estuarine Research, Volume II: Geology and Engineering, edited by L. Eugene Cronin, Academic Press, Inc., New York, 1975, p.201-216.

Wachapreague Inlet, Virginia, was monitored over a 13-month period to document the cross-sectional area response of the channel to short-term variations in wave activity and hydraulic inputs. The offset inlet channel, whose length is 1.5 km, width 500 m, and maximum depth 20 m, was surveyed 46 times in the 13 months. The significant conclusions are: (a) The complex basin-storage characteristics result in an ebb-dominated net sand transport over the long term. (b) The channel responds very quickly to storm events and large tidal prisms with changes of 10-15 percent in cross-sectional areas occurring within a few days. (c) Although the channel-area response is reasonably correlated with the ratio of ebb-tidal power to wave power, the short-term net sediment transport characteristics play a large role. (d) The volume of sand injected into the channel cannot reasonably be attributed to longshore drift alone; a significant but undetermined portion of it is due to transfer of material on and off the ebb delta. (e) The steric changes in sea level play a strong role in inlet maintenance where complex storage systems are involved. References (15 items).

Byrne, R.J., DeAlteris, J.T., and Bullock, P.A. Channel Stability in Tidal Inlets: A Case Study. Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, Copenhagen, Denmark, vol.II, 1975, Chapter 92 (p.1585-1604).

Wachapreague Inlet, a downdrift offset inlet in the barrier island complex of the mid-Atlantic U.S. coast, was studied during the period 1971-1973. Elements of the study included: (1) the inlet morphometric history (120 years), (2) assessment of surficial and sub-bottom sediments within the inlet complex, (3) response of the channel cross-sectional area to short-term variations in wave activity and tidal volumes, and (4) the distribution of tidal flows within the channel. It is concluded that: (1) a qualitative correlation exists between short-term channel cross-sectional area change and the ratio of ebb tidal power to wave power. It is inferred that the important element is the direct wave activity on the ebb-tidal delta; (2) duration differences in rising and falling phases of the tide (flood longer than ebb) lead to an ebb dominence in bedload capacity at the inlet with the result that this inlet has a natural flushing ability; (3) there is pronounced sand circulation within the inlet complex via a sediment flow loop which is driven by wave refraction and lateral inflow on the updrift side. The sand volumes thus delivered annually to the inlet channel from the ebb delta appear to far exceed the estimated littoral drift. The local sand circulation should, therefore, be considered in engineering design for inlet control structures. References (17 items).

Carmichael, J.W., and MacInnis, I. Performance Assessment of Self-Dredging Harbour Entrances. Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, vol.II, 1975, Chapter 87 (p.1491-1502). (See annotation in Section V.)

Cederwall, K., and Svensson, T. Sediment Flushing After Dredging in Tidal Bays. Journal of the Hydraulics Division, Proc. ASCE, vol.102, No.HY7, p.935-953, July 1976. (See annotation in Section VI.)

Chamley, H. Considérations sur la sedimentologie des estuaires (Estuarine Sedimentology). LA HOUILLE BLANCHE, vol.29, No.1/2, p 123-128, 1974. (In French.)

After a brief review of morphological features, types of sediment observed in estuaries and their distribution are described. Sediment dynamics are then discussed, especially as related to river flow conditions, the tide cycle and sedimentological variation in estuaries over a period of time. Bibliography (14 items). With discussion.

Chen, C.W., Smith, D.J., Jackson, J.D., et al. Organic Sediment Model for Wastewater Outfall. Symposium on Modeling Techniques, 2nd Annual Symposium of the Waterways, Harbors and Coastal Engineering Division of ASCE, San Francisco, California, September 3-5, 1975, vol.I, p.179-207. (See annotation in Section VI.)

Chen, Y.H., Lopez, J.L., and Richardson, E.V. Mathematical Modeling of Sediment Deposition in Reservoirs. Journal of the Hydraulics Division, ASCE, vol.104, No.HY12, p.1605-1616, December 1978.

When a dam is constructed across a river basin to form a reservoir the velocity of the flow in the reservoir is reduced and the sediment transported by the river is deposited. These deposits accumulate to form deltas. Estimation of the amount and location of the sediment deposits is required for engineers in the design of dams. A mathematical model is developed for prediction of the delta formation in the reservoir by considering the river-reservoir system as a whole. The river is modeled by a single channel assuming one-dimensional flow phenomena are predominant, whereas a compound stream model approach is used to simulate the main river and the flood plains in the reservoir. The jet theory is incorporated in the mathematical model and the resulting flow field is used to route the sediment through the reservoir. The simulated bed profiles generated by the mathematical model compare well with measured data. References (8 items).

Chesapeake Research Consortium, Inc., The The Effects of Tropical Storm Agnes on the Chesapeake Bay Estuarine System. The Johns Hopkins University Press, Baltimore and London, CRC Publication No.54, November 1976. (See annotation in Section VIII.)

Christensen, B.A., and Snyder, R.M. Physical Modeling of Scour Initiation and Sediment Transport in Distorted Tidal Models. Symposium on Modeling Techniques, 2nd Annual Symposium of the Waterways, Harbors and Coastal Engineering Division of ASCE, San Francisco, California, September 3-5, 1975, vol.II, p.927-935. (See annotation in Section VI.)

Christodoulou, G.C., Leimkuhler, W.F., and Ippen, A.T. Mathematical Models of the Massachusetts Bay. Part III. A Mathematical Model for the Dispersion of

Suspended Sediments in Coastal Waters. Ralph M. Parsons Laboratory for Water Resources and Hydrodynamics, Massachusetts Institute of Technology, Report No.179, January 1974.

A three-dimensional analytical model of the dispersion of fine suspended sediments in coastal waters is proposed. It predicts sediment concentration as a function of space and tidal time and the deposition pattern in the area around a continuous vertical line source. Data required are the sediment settling velocity (collected in this case from laboratory experiments), the hydrodynamic features of the area (obtained from field data), the net drift and tidal velocities and the dispersion coefficients. Vertical and horizontal distributions are treated independently. The model is applied to a hypothetical dredging problem in Massachusetts bay. The most important factors in the dispersion of fine sediments in coastal areas appear to be the net drift and settling velocity. References (33 items).

Conomos, T.J., and Peterson, D.H. Suspended-Particle Transport and Circulation in San Francisco Bay: An Overview. Estuarine Processes, Volume II, Circulation, Sediments, and Transfer of Material in the Estuary, edited by Martin Wiley. New York, Academic Press, 1977, p.82-97.

Differences in the relative magnitude and timing of wind stress and river inflow in the northern and southern reaches of San Francisco Bay create different sedimentary conditions. The northern reach is a partially to well mixed estuary receiving most of the total annual fresh-water input (840 m^3 sec^{-1}) and suspended sediment input (4×10^6 metric tons) into the bay; more than 80% of the sediment is received during winter. Density-driven nontidal estuarine circulation (~ 5 cm sec^{-1}) maintains a turbidity maximum which changes seasonally in particle concentration (40 to 80 mg $litre^{-1}$). Strong tidal currents ($\leq$ 225 cm sec^{-1}) and wind-generated waves resuspend sediment from the shallow bay floor; some of the riverborne sediment deposited during winter is resuspended during summer and transported landward to the turbidity maximum. Long-term sediment data (extrapolated from bathymetric charts) indicate that the northern reach is an effective sediment trap. In contrast, long-term sediment data suggest that the southern reach is experiencing net erosion. The southern reach receives little river inflow or riverborne suspended sediment, and the average nontidal circulation is weak ($\leq$ 2 cm sec^{-1}). The principal source of suspended sediment (25 mg $litre^{-1}$) in the southern reach is the shallow bay floor (average depth 6 m). References (41 items).

Costa, S.L., and Isaacs, J.D. Anisotropic Sand Transport in Tidal Inlets. Symposium on Modeling Techniques, 2nd Annual Symposium of the Waterways, Harbors and Coastal Engineering Division, of ASCE, San Francisco, California, September 3-5, 1975, vol.I, p.254-273. (See annotation in Section VI.)

Cronin, L.E., Pritchard, D.W., Koo, T.S.Y., et al. Effects of Enlargement of the Chesapeake and Delaware Canal. Estuarine Processes, Volume II, Circulation, Sediments, and Transfer of Material in the Estuary, edited by Martin Wiley. New York, Academic Press, 1977, p.18-32. (See annotation in Section I.)

Dalrymple, R.W., Knight, R.J., and Middleton, G.V. Intertidal Sand Bars in Cobequid Bay (Bay of Fundy). In: Estuarine Research, Volume II: Geology and Engineering, edited by L. Eugene Cronin, Academic Press, Inc., New York, 1975, p.293-307.

The largest tides in the world, with an average perigee spring range of 15.4 m and a maximum measured range of 16.3 m, occur at Burntcoat Head, on the south shore of Cobequid Bay. The tides generate currents with speeds of 1 to 1.5 m/sec in the center of Cobequid Bay. These currents, and waves approaching mainly from the west, have reworked sand derived from glaciofluvial outwash and cliff erosion of bedrock into a major sand body which occupies the eastern part of the Bay. The sand body is 30 km long and 6 to 25 m thick. Most of it is subtidal, but close to shore and at the east end of the Bay there are several intertidal sand bars, which reach 6 m or more in relief and thickness and have dimensions up to 4 kms in length. Maximum speeds of tidal currents over the bar surfaces generally range from 0.5 to 1 m/sec; the strength and direction are largely determined by shore and bar topography. In many areas either flood or ebb currents dominate, producing strongly asymmetrical patterns of sand dispersal. Bars are covered by sand waves (with wavelengths of the order of 30 m; these are not found on all bars), megaripples (with wavelengths in the range 1.5 to 5 m) and ripples. Many megaripples can be observed on depth

recordings to reverse their orientation during each ebb or flood. On Selmah Bar, sand waves are flood-oriented and covered at low tide by ebb-oriented megaripples. The sand waves are found only on the south side of the bar in a low area (not affected by wave action) that is strongly dominated by flood currents, and they migrate about 20 cms per tidal cycle. References (29 items).

DeAlteris, J.T., and Byrne, R.J. The Recent History of Wachapreague Inlet, Virginia. In: Estuarine Research, Volume II: Geology and Engineering, edited by L. Eugene Cronin, Academic Press, Inc., New York, 1975, p.167-181.

The configuration of Wachapreague Inlet has been traced since 1852 to the present from bathymetric surveys and aerial photographs. During the last 120 years this offset tidal inlet has migrated to the south at a rate of 1 meter per year. A cyclic growth and decay of the lateral ramp margin shoals has been documented over the last 24 years. These variations are not likely due to variations in littoral drift along the adjacent islands. A study of the net long-term sand-volume changes on the ebb-tidal delta shows no significant long-term change in the storage of sand. The mobile sediment distribution of the inlet was investigated with respect to spatial variations over the entire inlet complex and temporal variations in the deep inlet throat. The sediment distribution correlated well with the various depositional environments ranging from gravels in the deep inlet throat to silty sands on the flood-tidal delta. Changes in the inlet throat sediment distribution were monitored over a 3-month period. Short-term fluctuations in the inlet cross-sectional areas were correlated with overall changes in the bottom sediment characteristics in the inlet throat. Investigation into the geomorphology of the inlet orifice shows the north flank to be a sandy spit extending south from the barrier island, while the south flank is a firm cohesive lagoonal mud. Thus, as Wachapreague Inlet migrates south in response to a predominantly southerly littoral drift, it leaves in its path a wedge of sand (the only sand sink in the system) and erodes into firm marine lagoonal deposits. References (6 items).

Dean, R.G., and Walton, T.L., Jr. Sediment Transport Processes in the Vicinity of Inlets with Special Reference to Sand Trapping. In: Estuarine Research, Volume II: Geology and Engineering, edited by L. Eugene Cronin, Academic Press, Inc., New York, 1975, p.129-149.

Paper presented at the Second International Estuarine Research Conference, held by the U.S. Estuarine Research Federation at Myrtle Beach, South Carolina, 15-17 October 1973. A method is described and applied for calculating the materials accumulated in the outer shoals adjacent to inlets. The calculated outer shoal accumulations are presented for twenty-three Florida inlets; these volumes range from approximately 1 million cubic yards for Jupiter Inlet to more than 200 million cubic yards for Boca Grande Inlet. Calculated volumetric accumulations in inner bars and shoals are presented for four Florida inlets. This procedure contains inherent errors associated with changes of horizontal and vertical datums between earlier and later surveys. One conclusion of this study is that stabilization of inlets, particularly in areas of low wave energy, results in an offshore shoal of continuously increasing volume. The relatively high wave energy and strong currents on these shoals would winnow out the fine materials, leaving only coarser material suitable for beach-nourishment purposes. The volumes of these shoals are very significant when evaluated in terms of the erosion of adjacent barrier islands. As an example, for the estimated present total outer shoal volumes in Florida and the present rate of erosion along Florida's shoreline, these outer shoals contain enough material to forestall erosion for 76 years.

Diener, R.A. Cooperative Gulf of Mexico Estuarine Inventory and Study -- Texas: Area Description. National Marine Fisheries Service, Galveston, Texas, Gulf Coast Fisheries Center, NOAA (National Oceanic and Atmospheric Administration) Technical Report NMFS CIRC-393, September 1975. (See annotation in Section VIII.)

Doiron, L.N., and Whitehurst, C.A. Channel Erosion in Southwestern Louisiana Canal. Journal of the Waterway, Port, Coastal and Ocean Division, Proceedings, ASCE, vol.104, No.WW2, p.201-213, May 1978.

Geomorphic processes active in the man-made Southwestern Louisiana Canal are studied with the aid of color infrared and multiband imagery aerial photography and various field analysis techniques. The enlargement and shoaling of the canal are investigated to determine their causes, and to quantify the rates of erosion and deposition in a man-made structure of historically known dimensions in the bidirectional tidal flow regions of an estuarine environment. References (20 items).

Dronkers, J.J., and Venis, W.A. Hydraulic and Soil-Mechanical Aspects of Enclosures in Estuaries. Transactions, Eleventh International Congress on Large Dams, Madrid, Spain, 11-15 June 1973, vol.II, Question No.41, p.1421-1438, Report 75. (See annotation in Section V.)

Dubach, H.W., Compiler. The North Carolina Coastal Zone and Its Environment; A Compilation of Resource Materials Covering the Coastal Plain, Estuaries, and Offshore Waters. Savannah River Laboratory, Aiken, South Carolina, DP-1423, November 1977. 2 vols.

Vol.I. General.-Biology.-Engineering.-Fish and Fisheries.-Geology and Geophysics. Vol.II. Hydrology and Groundwater.-Oceanography.-Weather and Climate.-Miscellaneous.-Charts, Maps, and Atlases. 1786 entries.

Dyer, K.R. The Measurement of Bed Shear Stresses and Bedload Transport Rates. Estuarine Processes; Volume II, Circulation, Sediments, and Transfer of Material in the Estuary, edited by Martin Wiley. New York, Academic Press, 1977, p.124-135. (See annotation in Section VII.)

Ecker, R.M., and Hendricks, J.W. Factors Affecting the Distribution of Contaminants in an Estuary. In: Dredging: Environmental Effects & Technology; Proceedings of WODCON VII, San Francisco, California, July 10-12, 1976, p.69-84. (See annotation in Section IV.)

Edzwald, J.K., and O'Melia, C.R. Clay Distributions in Recent Estuarine Sediments. CLAYS AND CLAY MINERALS, vol.23, No.1, p.39-44, 1975.

The distribution of clay minerals in Recent sediments can be explained by the relative stability of the clays. The rates of particle aggregation for three clays were determined in the laboratory in synthetic estuarine solutions; from the kinetic studies stability values were calculated. The results indicate that illite is more stable than kaolinite which is more stable than montmorillonite. The distribution of the clays in the Pamlico River Estuary can be explained on the basis of relative clay stability where kaolinite which aggregates rapidly (relatively unstable clay) is found upstream of illite. References (23 items).

Emerson, R.R. Heavy Metal Concentrations in Marine Organisms and Sediments Collected near an Industrial Waste Outfall. Proceedings of the International Conference on Environmental Sensing and Assessment, Las Vegas, Nevada, September 14-19, 1975, vol.I.

Sediments and organisms from the bottom and water column were analyzed by atomic absorption for cadmium, chromium, copper, iron, manganese, nickel, lead and zinc. Concentration levels in the sediments were reduced in correspondence with the distance from the outfall, but concentration levels in the tissues of the organisms did not correspond similarly. Tissue concentrations were mostly below sediment concentrations by an order of magnitude, but varied independently of phylogenetic affinities. Uptake and regulatory capabilities of marine organisms may be related to feeding strategies and environmental contamination levels. References (46 items).

Emmett, W.W., and Thomas, W.A. Scour and Deposition in Lower Granite Reservoir, Snake and Clearwater Rivers near Lewiston, Idaho, U.S.A. JOURNAL OF HYDRAULIC RESEARCH, vol.16, No.4, p.327-345, 1978.

Calculation of the final levee grades for Lower Granite Reservoir at Lewiston, Idaho, required adjustment to the streambed to account for sediment deposits during the 50-year life of the project. Since the backwater reach of the reservoir behaves like a sediment trap during low flow and re-entrains material during high flow, both deposition and scour influence the final bed profile with the coarser material playing a dominant role. The simulation technique used to distribute sediment deposits (computer program known as "Scour and Deposition in Rivers and Reservoirs") required data on inflowing sediment load, gradation of the load, gradation of material on the streambed, water-discharge hydrographs, and operating policies for the reservoir. Sediment data were lacking, so a collection program was initiated to satisfy two objectives: (1) to provide sediment-inflow data for the study, and (2) to calibrate the simulation technique. The field data, including bedload-transport rates, provide one of the most complete sets of sediment data for large rivers. The simulation program was calibrated using data collected in the field and the final, calculated levee grade is lower than would have resulted without that field data. References (15 items).

Everts, C.H., and Moore, H.E. Shoaling Rates and Related Data from Knik Arm near Anchorage, Alaska. U.S. Army Coastal Engineering Research Center, Technical

Paper No.76-1, March 1976. (See annotation in Section VII.)

Faas, R.W., and Wartel, S.I. Sedimentology and Channel Slope Morphology of an Anoxic Basin in Southern Netherlands. Estuarine Processes; Volume II, Circulation, Sediments, and Transfer of Material in the Estuary, edited by Martin Wiley. New York, Academic Press, 1977, p.136-149.

The Veerse Meer is a brackish, non-tidal lake in southern Netherlands. It was separated from the tidal OosterSchelde in 1961 by dams at each end. Environmental and sedimentological changes are occurring that are different from the parent water body. Bottom conditions range from well-oxidized to completely anoxic. Physical properties of the bottom sediments vary, depending upon the bottom water conditions. Bioturbation in aerobic areas has mixed the pre- and post-1961 sediments. Areas which became anoxic shortly after enclosure show a lack of mixing, with post-1961 clayey sediments lying directly over pre-1961 sandy sediments. Extensive levelling of the pre-1961 bottom is occurring with fine-grained sediments accumulating in scour pits and depressions. Channel slope measurements show three distinct *morphologies*, each reflecting changes in the dynamic history of the estuary. "Cliffed" slopes are relict features from the pre-1961 tidal system. "Steep" slopes are found adjacent to channel sides in anoxic environments and contain fine-grained sediments. "Gentle" slopes found adjacent to mid-channel sand islands are composed of coarser-grained sediments. Nature of post-1961 sedimentation appears directly influenced by 1) biologic activity, 2) wind wave and boat wake winnowing, 3) proximity to polder drainage channels and tidal flats, and 4) lack of tidal activity. References (13 items).

Finley, R.J. Hydraulics and Dynamics of North Inlet, South Carolina, 1974-75. U.S. Army Corps of Engineers, General Investigation of Tidal Inlets, GITI Report 10, September 1976. (See annotation in Section I.)

Finley, R.J. Hydrodynamics and Tidal Deltas of North Inlet, South Carolina, In: Estuarine Research, Volume II: Geology and Engineering, edited by L. Eugene Cronin, Academic Press, Inc., New York, 1975, p.277-291.

A one-year study at North Inlet, South Carolina, has documented a pattern of changing bathymetry, eroding shorelines, and generally westward migration of the entire system. The ebb-tidal delta is large with prominent and changeable channel-margin linear bars. Tidal currents have maintained an equilibrium cross-section despite infilling of the main ebb channel with sediment eroded from updrift beaches. The only beaches not eroding are those protected from northeast waves by the ebb-tidal delta. The flood-tidal delta is much smaller than those of New England estuaries and is strongly influenced by wave swash at high tide. Only a few poorly developed sand waves are present, and the area of bedforms that remains flood-oriented at low tide is small. The seaward projecting ebb spit divides the flow between two main tidal creeks. The delta and flanking arcuate sand ridges are migrating over the adjacent Spartina marsh. Measurements of the beach profile provide additional evidence of a transgressive shoreline. Hydrographic measurements over fourteen complete tidal cycles reveal generally ebb-dominated channels and flood-dominated subtidal flats. Maximum velocities measured are near 80 cm/sec, and time-velocity and current-velocity asymmetry are present. References (6 items).

Forth-Tay Estuaries, The (An Environmental Assessment). Papers, Symposium held in the Rooms of the Royal Society of Edinburgh, October 29, 1971. In: The Royal Society of Edinburgh, Proceedings, Section B, vol.71, Parts 2/4, p.97-226, 1972. (See annotation in Section VIII.)

Gallenne, B. Study of Fine Material in Suspension in the Estuary of the Loire and Its Dynamic Grading. ESTUARINE AND COASTAL MARINE SCIENCE, vol.2, p.261-272, July 1974.

The tidal and seasonal movements of the turbidity maximum and the fluid mud layer of the Loire estuary were investigated and related to the concentrations of different clay minerals. The concentrations of Illite and Montmorillonite are shown to be inversely related, while Montmorillonite reaches a maximum concentration, approximately 40% of clay minerals present, in the zone between the turbidity maximum and the fluid mud. Seasonal variations show that the concentration of Montmorillonite moves with the turbidity maximum. References (20 items).

Gibbs, R.J. Distribution and Transport of Suspended Particulate Material of the Amazon River in the Ocean. Estuarine Processes, Volume II, Circulation,

Sediments, and Transfer of Material in the Estuary, edited by Martin Wiley. New York, Academic Press, 1977, p.35-47.

The transport of suspended material of the Amazon River was determined based on data from seven cruises in the Amazon River/Atlantic Ocean area with measurements of currents, suspended material concentration, temperature, and salinity made at three anchored stations extending over complete tidal cycles. The suspended material is thrust out the river mouth onto the shelf where it encounters a two-layer flow with entrainment and mixing. It is also carried westward along shore by a strong ocean current, as well as by prevailing longshore currents. Off the river mouth, transport is oceanward at all depths with the majority being transported in the lower half of the water column. There is a transition oceanward until the upper third of the water column on the outer shelf has negligible suspended material transport, the middle third is transported oceanward, and the bottom third of the column is transported landward. A state of equilibrium existing between the bottom transports produces a turbidity maximum out on the shelf oceanward of the river mouth and extending northwestward parralleling the coast. The sedimentation patterns are in opposition to the classic pattern with sands and silts on the shelf and winnowed mud being deposited on the coast. References (5 items).

Giese, E. Stability Problems for the Navigation Channel in a Tidal River. In: Rivers '76; Symposium on Inland Waterways for Navigation, Flood Control and Water Diversions; 3rd Annual Symposium of the Waterways, Harbors and Coastal Engineering Division of ASCE, Colorado State University, Fort Collins, August 10-12, 1976, vol.I, p.280-295, 1976. (See annotation in Section VI.)

Giese, E., and Vollmers, H. On the Reproduction of Morphological Changes in a Coastal Model with Movable Bed. Proceedings, XVIth Congress of the International Association for Hydraulic Research, São Paulo, Brazil, July 27 to August 1, 1975, vol.1, Paper A8. (See annotation in Section VI.)

Godfrey, P.J., and Godfrey, M.M. Some Estuarine Consequences of Barrier Island Stabilization. In: Estuarine Research, Volume II: Geology and Engineering, edited by L. Eugene Cronin, Academic Press, Inc., New York, 1975, p.485-516. (See annotation in Section V.)

Göhren, H. Dynamics and Morphology of Sand Banks in the Surf Zone of Outer Tidal Flats. Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, Copenhagen, Denmark, vol.II, 1975, Chapter 50 (p.871-883).

Extended sand banks ranging up to some hundred acres with a crest height in the MHW-level are typical structures of the outer tidal flats of the southeastern North Sea coast (Fig. 1). Primary forms grow up in the surf zone at the sea-side tidal flat border. They are formed like bars and migrate towards the coast with a surprisingly high velocity, up to 150 m/year. The movement is caused by strong erosion on the sea-side slope - which is shaped beach-like - and deposition at the steeper land-side (lee-side) slope. It was found that surf action at the bar is linked with strong unidirectional currents across the crest, up to 100 cm/s. The currents are most likely generated to wave set-up in front of the bank and by wind-drift water motion. The migration velocity of the sand banks decreases with increasing distance from the tidal flat border. This effect seems to be most important when generation of new banks continues. It leads to "overtaking" and "interaction" of the single structures, thus growing together and building up the large sand banks as described above and gives an explanation of the development of large offshore sand banks and dune islands on tidal flats. References (10 items).

Goldsmith, V., Byrne, R.J., Sallenger, A.H., et al. The influence of Waves on the Origin and Development of the Offset Coastal Inlets of the Southern Delmarva Peninsula, Virginia. In: Estuarine Research, Volume II: Geology and Engineering, edited by L. Eugene Cronin, Academic Press, Inc , New York, 1975, p.183-200.

Comparisons of the bathymetric surveys of 1852 and 1934 indicate that during that 82-year interval these barrier islands became substantially offset (up to 1 km) seaward on the downdrift side of the inlets. The inlets migrated southward while the ebb-tidal deltas remained stationary. The offshore bathymetry underwent concomitant changes within the same 82-year interval, most notably in the ridge-and-swale bathymetry, which deepened in the troughs and built upward on the crests. This and other detailed analyses of the bathymetry has encouraged high confidence in the older bathymetric survey. Using standard computational wave-refraction techniques and the older bathymetry, it was determined that in 1852 the shorter-wavelength northeast

waves (T = 4-6 sec) tended to concentrate wave energy at the south ends of these islands, whereas longer northeast waves (T = 12 sec) tended to concentrate wave energy at the north ends of the islands. Moreover, the longer waves approached the shore with their wave orthogonals closer to the perpendicular of the shoreline than did the shorter waves. Thus, the more accretional waves built up the shoreline on the downdrift sides of the inlets, while the shorter erosional waves eroded the shoreline on the updrift sides. This effect was amplified by a feedback mechanism: the more the inlet offset the greater the refraction of the longer waves, which resulted in more buildup and a decrease in littoral drift, especially to the north. This computed wave behavior is consistent with both the long-term volumetric stability and the extreme volumetric fluctuations observed annually by DeAlteris and Byrne (4) and Byrne, et al. (2) for these offset inlets. However, since 1852 there has been a tendency for the shoreline wave-energy distribution to become more uniform along any one of these barrier islands, which suggests that when the wave-energy distribution reaches equilibrium the growth of the inlet offsets will cease, and the inlets will become more stable. References (9 items).

Gole, C.V., Tarapore, Z.S., Brahme, S.B., et al. Dynamic Behaviour of Coastal Inlets. Proceedings, XVIth Congress of the International Association for Hydraulic Research, São Paulo, Brazil, 27 July to August 1, 1975, vol.1, Paper A25.

Present methods used for predicting behavior of coastal inlets are confined to what are called stable inlets. Some inlets however show a tendency towards sudden closure and sudden enlargement due to variation in littoral drift and fresh water discharge and criteria established on the basis of stable inlets are no longer valid. A study of the dynamics of coastal inlets was therefore undertaken. This method involves assessment of the quantities of siltation and erosion in various zones around the inlet by studying the velocity field caused by flood and ebb tides and alongshore littoral currents. With this method, seasonal behavior of coastal inlets can be examined. References (8 items).

Goodwin, C.R. Estuarine Tidal Hydraulics: One Dimensional Model and Predictive Algorithm. Ph.D. Thesis, Oregon State University, June 1974. (See annotation in Section VI.)

Gordon, R.B. Dispersion of Dredge Spoil Dumped in Near-Shore Waters. ESTUARINE AND COASTAL MARINE SCIENCE, vol.2, No.4, p.349-358, October 1974.

Turbidity measurements show that 99% of noncohesive spoil of high silt content discharged from a scow in the presence of a tidal stream is transported to the bottom as a high speed, turbulent jet. Lateral spread of the jet is about 30% of the water depth. Impact with the bottom produces an outward speading density current whose speed and thickness vary such that the Froude number of the flow remains about constant. When 2000 m^3 of spoil is discharged in water 20 m deep, the density surge carries less than 18% of the spoil outside a circle of 30-m radius and essentially none beyond about 120 m. The residual turbidity in the water column, which drifts with the tidal stream, contains less than 1% of the material discharged; this settles at the fall velocity of the individual particles. References (4 items).

Green, C.D. Sediments of the Tay Estuary. III. Sedimentological and Faunal Relationships on the Southern Shore at the Entrance to the Tay. The Royal Society of Edinburgh, Proceedings, Section B, vol.75, Parts 1/2, p.91-112, 1975.

The southern entrance shores to the Tay estuary form an area of extensive intertidal sedimentation. Tidal currents of varying strengths characterize the area and the situation is modified by both wind and wave. The net result is a series of seven sub-environments of sedimentation. The textural characteristics of the sediment and the distribution of major and minor sedimentary structures in each subenvironment is closely linked to stability and changing physical processes. The distribution of organisms, live and dead, provides a good indication of these patterns of sediment and stability. References (10 items).

Green, C.D. A Study of Hydraulics and Bedforms at the Mouth of the Tay Estuary, Scotland. In: Estuarine Research, Volume II: Geology and Engineering, edited by L. Eugene Cronin, Academic Press, Inc., New York, 1975, p.323-344.

An attempt has been made to link directly the bedforms and sequence of bedform changes in a tidal channel to the tidal currents and associated critical erosion velocities. No satisfactory relationship has been established. Reynolds

numbers show the tidal currents to be in fully developed turbulent flow. Froude numbers, whilst characterizing the transitional and lower flow stages, do not allow the delimitation of the stage of initiation of motion, neither do they permit the characterization of the sequences of bedform change. Shear stress and shear velocity values based on bed-slope calculations are inappropriate in tidal waters and those based on water-surface slope are of limited value. Shear stresses derived from velocity gradients enable a critical shear stress value for the initiation of particle motion to be suggested. Sequences of bedform change can be correlated more directly with von-Karman-Prandtl values than with any other single parameter. In attempting to define the ranges of flow conditions associated with various bedform stages it is necessary to question the validity of extrapolating from steady-state experiments to the natural tidal system. The study illustrates this point and suggests a basic four-fold division of bedform stages. References (25 items).

Grenney, W.J., Porcella, D.B., and Cleave, M.L. Water Quality Relationships to Flow -- Streams and Estuaries. In: *Methodologies for the Determination of* Stream Resource Flow Requirements: An Assessment, edited by C.B. Stalnaker and J.L. Arnette; Utah State University, Logan, 1976, p.35-88. (See annotation in Section VI.)

Gross, M.G. Effects of Waste Disposal Operations in Estuaries and the Coastal Ocean. In Annual Review of Earth and Planetary Sciences, vol.6, p.127-143, 1978.

Waste solids, including dredged materials, rubble, sewage sludge, and industrial wastes, are discharged in estuaries and coastal ocean areas. The largest volumes and the largest discharges of solids come from dredging operations and from sludges produced by sewage treatment plants. Because of the large volumes of materials and the many disposal operations at sea, waste deposits are of geological significance in urbanized coastal areas. Deposits of wastes can be detected by their black color, human artifacts, high carbon content, and content of metals such as silver, copper, chromium, and lead. Waste deposits form hills and cover large areas on the continental shelf. Submarine canyons have been filled by waste deposits. Physical alterations of the bottom have caused obvious changes in abundance and distribution of bottom-dwelling organisms. Accumulations of sewage sludges on the ocean bottom are associated with diseases in crustacea and fin erosion in certain bottom-dwelling fishes. Low dissolved oxygen concentrations have occurred in coastal ocean areas during late summer, apparently caused by river-borne nutrients rather than disposal of barged wastes. Regulation of ocean disposal of wastes has eliminated small-volume industrial discharges. In the United States large volumes of sewage sludge and dredged wastes are still discharged at sea. Literature Cited (65 items).

Gross, M.G. Sediment and Waste Deposition in New York Harbor. Hudson River Colloquium. Annals of the New York Academy of Sciences, vol.250, p.112-128, May 24, 1974.

In this paper the physical alterations of the Hudson River estuary are discussed. Particular attention is paid to the sediments and waste deposits that covered much of the harbor bottom and large areas of New York Bight in 1972. From these two examples we can see the importance of man as a geologic and oceanographic agent. References (36 items).

Hacker, S. *Transport* Phenomena in Estuaries. Dissertation, Ph.D., Louisiana State University, August 1973.

Two dimensional time-dependent estuarine transport equations were developed to predict velocity profiles, temperature distributions and salinity distributions as a function of time knowing environmental conditions, tidal variations and fresh water flows into the bay-marsh system. These equations were solved numerically on a digital computer for the Barataria Bay region of Coastal Louisiana. Results were obtained for the Barataria Bay estuary for the following cases: typical conditions, high fresh water runoff, drop in Gulf salinity due to meandering Mississippi River waters, cold front passage, and a tidal wave due to a hurricane. Also, results obtained were compared to field data, and those results obtained by other investigators in similar studies. From the results obtained the following conclusions were made: high fresh water runoff caused isohalines to move towards the Gulf, a drop in Gulf salinity due to meandering Mississippi River waters created pockets of high salinity inside the bay, cold front passage caused the temperatures in the marsh to drop more than in the open bay waters, the tidal wave caused the isohalines to recede into the upper reaches of the bay. The model was found to accurately predict the dynamics of

Barataria Bay when compared with the available experimental data. For the typical conditions studied the model reaches a quasi-steady state in three to five tidal cycles. The terms of the time-averaged transport phenomena models were evaluated and it was found that the terms generated by the time integration cannot be neglected. Therefore, these time-averaged terms have to be evaluated in some form if the time-averaged model is to be of use. References at end of each chapter.

Hahn, H.H. and Klute, R. Pollutional Effects of Suspended Sedimented and Eroded Particulate Material in the Aqueous Environment. Proceedings of the International Conference on Environmental Sensing and Assessment, Las Vegas, Nevada, September 14-19, 1975, vol.I. (See annotation in Section IV.)

Haines, E., Chalmers, A., Hanson, R., et al. Nitrogen Pools and Fluxes in a Georgia Salt Marsh. Estuarine Processes; Volume II, Circulation, Sediments, and Transfer of Material in the Estuary, edited by Martin Wiley. New York, Academic Press, 1977, p.241-254.

Preliminary data on standing stocks of nitrogen and on rates of nitrogen fixation and denitrification in Spartina alterniflora salt marshes on the Georgia coast have yielded a general concept of the nitrogen cycle in this system. The Georgia salt marsh is characterized by fine-textured clay soils, a tidal amplitude of two meters, and high rates of primary production throughout the year. Most combined nitrogen in the system is in the soils in forms not readily available to primary producers. The amounts of exchangeable ammonium, nitrate, and nitrite are small and change seasonally. The presence of nitrate and nitrite in the soil implies that nitrification occurs in the aerobic microzones around Spartina roots. The annual input to the marsh via nitrogen fixation and other quantified sources of nitrogen is as large as the seasonal accumulation of nitrogen by Spartina growth; the input is balanced by the loss of nitrogen via denitrification. The nitrogen input to the marsh is, however, smaller than the estimated nitrogen flux through the marsh plants. Thus, mineral regeneration must satisfy a large part of the nitrogen requirements of Spartina and benthic algae in the Georgia salt marsh. References (42 items).

Halliwell, R., and O'Connor, B. Quantifying Spoil Disposal Practices. Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, Copenhagen, Denmark, vol.III, 1975, Chapter 153 (p.2581-2600).

The results of an extensive field study undertaken in the Mersey Estuary and its approach channels are briefly described. These measurements were undertaken to obtain a quantitative understanding of the movement and circulation of water and sediment in the area. There is considerable dredging activity required in the area and the spoil from such operations is, at the present time, deposited at an offshore site in Liverpool Bay. A simple model is presented which attempts to quantify the movement of sediment into and within the Mersey system. The field measurements showed that considerable quantities of sediment return to the docks, estuary and approach channels from the spoil ground. The model includes this fact and attempts to quantify the amounts returning to various areas. The model equations were applied to each year of the period 1955-65 to determine the various factors and to test its validity; this required the use of the annual hydrographic surveys and dredging records as well as the results of the field measurements. Finally, the model was used to compare the probable results of a number of possible schemes including resiting of the spoil ground, pumping all dredged material ashore and free-dumping of dock dredgings in the estuary itself. References (13 items).

Hard, C.G. Aspects of Dredged Material Research in New England. In: Estuarine Research, Volume II: Geology and Engineering, edited by L. Eugene Cronin, Academic Press, Inc., New York, 1975, p.537-540.

The New England Division of the Corps of Engineers has had a dredging research program going for several years. Early emphasis was on gross bathymetry, turbidity, and the repopulation of benthic organisms. Present orientation is towards offshore physical and soil mechanics and mathematical modeling pointing towards improved disposal equipment and methods. The program is understaffed but receives good cooperation from other agencies and from the National Science Foundation. References (2 items).

Harten, H. Model Trials with Movable Bed Section for Improving the Main Navigational Channel of the Elbe River. Proceedings, XVIth Congress of the International Association for Hydraulic Research, São Paulo, Brazil, July 27 to

August 1, 1975, vol.1, Paper A7. (See annotation in Section VI.)

Hattersley, R.T. Estuarine Reclamations and the Environment. First Australian Conference on Coastal Engineering, Sydney, May 14-17, 1973; Engineering Dynamics of the Coastal Zone, p.123-130.

The case for land reclamation in estuaries with populated areas is reviewed and the effects of the construction of reclamations on the marine environment are discussed where feasible guide lines are suggested for engineering design. References (15 items).

Hayes, M.O. Morphology of Sand Accumulation in Estuaries: An Introduction to the Symposium. In: Estuarine Research, Volume II: Geology and Engineering, edited by L. Eugene Cronin, Academic Press, Inc., New York, 1975, p.3-22.

Paper presented at the Second International Estuarine Research Conference held by the U.S. Estuarine Research Federation at Myrtle Beach, South Carolina, 15-17 October 1973. Sand deposition in estuaries is a function of the interaction of a number of dynamic processes. The symposium papers have been organized so as to emphasize the importance of tidal range, and in this paper three basic models of estuarine sedimentation are proposed: (a) Microtidal model in which waves and wind tides dominate as the major processes; (b) Mesotidal model in which tidal delta deposits predominate; and (c) Macrotidal model which is dominated by tidal-current deposition. Details on sedimentation patterns and processes that occur in each type of estuary are presented in the papers that follow. References (12 items).

Heinle, D.R., Flemer, D.A., and Ustach, J.F. Contribution of Tidal Marshlands to Mid-Atlantic Estuarine Food Chains. Estuarine Processes; Volume II, Circulation, Sediments, and Transfer of Material in the Estuary, edited by Martin Wiley. New York, Academic Press, 1977, p.309-320.

The seasonal pulsing of flows of carbon from tidal marshes results in similarly pulsed production of zooplankton in some estuaries. Direct evidence, experimental feeding of laboratory copepods, and measurements of feeding by captured wild copepods, supports the hypothesis that detritus is rapidly incorporated into higher trophic levels. The timing of the production of copepods based on a detrital food source is such that year-to-year variations in amount may be an important factor in the survival of larvae of anadromous fish. References (30 items).

Herrmann, F.A., Jr. Movable-Bed Study of Galveston Bay Entrance. In: Estuarine Research, Volume II: Geology and Engineering, edited by L. Eugene Cronin, Academic Press, Inc., New York, 1975, p.93-110. (See annotation in Section VI.)

Hess, W.N., and Nelson, T.A. A Test Particle Dispersion Study in Massachusetts Bay. Seventh Annual Offshore Technology Conference, Houston, Texas, May 5-8, 1975; Proceedings, vol.I, Paper No. OTC 2160. (See annotation in Section VII.)

Hine, A.C. Bedform Distribution and Migration Patterns on Tidal Deltas in the Chatham Harbor Estuary, Cape Cod, Massachusetts. In: Estuarine Research, Volume II: Geology and Engineering, edited by L. Eugene Cronin, Academic Press, Inc., New York, 1975, p.235-252.

Well-developed, multi-component flood- and ebb-tidal deltas exist in the lower portion of the Chatham Harbor estuary, Cape Cod, Massachusetts. Each tidal delta contains several smaller sand bodies, a dominant bedform type, and a preferred bedform orientation, which indicates a distinct sediment transport pattern. The hydrography and overall geometry of the estuary are the critical factors in controlling these features on the tidal deltas. The estuary has two inlets, each facing a separate large body of water whose tidal ranges are significantly different. The tidal-range difference develops a steep hydraulic slope that occurs during flood and results in pronounced time asymmetry and tidal-current segregation. The ebb-tidal delta conforms to the model proposed by Hayes et al. (7). Tidal-current segregation has developed a deep, main ebb channel, which is flanked by two shallow marginal flood channels. These three channels are floored with unidirectionally-oriented sand waves. Net sand transport by tidal currents occurs in the proximal portion of the ebb-tidal delta, while net transport by wave-generated currents occurs in the distal portion. Nearly complete flood-tidal current dominance exists on the flood-tidal delta. The margins of this multi-lobate sand body have migrated approximately 900 m during a ten-year period, indicating rapid sand transport. Three bedform orientations develop during flood because of two changes in the direction of flow. The resulting dominant bedform feature is an intersecting pattern of two sand-wave orientations. References (9 items).

Hoffman, J.F. Decrease in Harbor Maintenance Dredging Through the Use of Pile Dikes and Related Structures Together with an Analysis of Estuarine Sedimentation Problems. U.S. Naval Academy, Energy-Environment Study Group, Report No. USNA-EPRD-29, 30 June 1976. (See annotation in Section V.)

Hoopen, H.G.H. ten, and Bakker, W.T. Erosion Problems of the Dutch Island of Goeree. Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, Copenhagen, Denmark, vol.II, 1975, Chapter 71 (p.1213-1231).

At many places along the Dutch coast, especially at the west side of the islands, erosion occurs. One of the islands where the erosion is severe is Goeree, situated in the Delta area in the southwest of the Netherlands. This isle is recently connected with other islands by dams. These dams are built within the scope of the Delta-project plans, closing the tidal estuaries and shortening the length of the coastline, thus reducing the wave attack. This paper examines how the influences of the closure of the estuaries affect the erosion of the neighboring coast. To this end, the changes in vertical and horizontal tide caused by the closure as well as the wave induced littoral drift and the sand-transport caused by a combination of tidal currents and waves before and after the closure, are computed. On the basis of these computations, a few suitable solutions for the reduction of erosion are discussed. References (15 items).

Hovers, G. Morphological Changes in a Fine Sand Tidal Estuary After Measures of River Improvement. Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, Copenhagen, Denmark, vol.II, 1975, Chapter 74 (p.1274-1288).

This report deals with the successes achieved in the improvement of the Outer Weser, the approach to the ports on the Lower Weser Bremen, Brake, Nordenham, and Bremerhaven, by means of artificial river structures.

Hubbard, D.K. Morphology and Hydrodynamics of the Merrimack River Ebb-Tidal Delta. In: Estuarine Research, Volume II: Geology and Engineering, edited by L. Eugene Cronin, Academic Press, Inc., New York, 1975, p.253-266.

A well-developed ebb-tidal delta occurs at the mouth of the Merrimack River, Massachusetts. The inlet is the site of artificial structures (groins, jetties, sea walls) that affect the ebb-tidal delta and adjacent beaches. Old maps and historical records show that, before stabilization, the ebb-tidal delta displayed all the features of the models of Oertel (5) and Hayes et al. (2) and that the inlet behaved as do natural mesotidal inlets observed today. Changes in the present ebb-tidal delta are the amplification of adjacent nearshore bars and the elimination of marginal flood channels and channel margin linear bars. Hydrography stations were monitored for 13 hours to determine tidal-current velocity and direction, salinity, and water temperature in and around the inlet. Bottom samples were collected by scuba divers at over 200 locations on the ebb-tidal delta. Semidaily wave readings (breaker height and type, approach angle, wave period and longshore drift) were taken along the beach and were related to changes in beach and inlet morphology. Wave-refraction diagrams simulating storm conditions (9-second waves approaching from the northeast) show a complex relationship between the morphology of the ebb-tidal delta, wave refraction, and man's intervention in the form of jetties and groins. The refraction of northeast waves around the ebb-tidal delta creates a reversal in the direction of longshore transport south of the inlet causing serious beach erosion. Groins have proved ineffective in maintaining the present beach and continue to cause local erosion. References (6 items).

Hung, C.S., and Shen, H.W. Statistical Analysis of Sediment Motions on Dunes. Journal of the Hydraulics Division, ASCE, vol.105, No.HY3, p.213-227, March 1979.

Statistical analyses were done on the movements of bed load particles over alluvial bed forms from data collected in a large laboratory flume at Colorado State University. The bed load particles were tagged by radioactive tracer -- Cesium 137. Statistical properties of the random variables and the correlations between these variables are investigated. It is found that within the test range, the mean and variance of longitudinal step length, the mean wavelength and the mean wave height of bed forms, the particle speed, the variance of vertical step length, and the variance of lateral step length all increase with the increase of flow. However, the coefficients of variation for both wave height and wavelength remain approximately the same for all flow conditions tested. The ratio of average wavelength to average wave height decreases with the increase of flow. References (13 items).

Ince, S., and Jamieson, W.W. Field and Model Studies for Visakhapatnam Harbor. Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, vol.II, 1975, Chapter 88 (p.1503-1523). (See annotation in Section VI.)

International Symposium on Interrelationships of Estuarine and Continental Shelf Sedimentation, Bordeaux, France, Institut de Geologie du Bassin d'Aquitaine, 9-14 July 1973; Proceedings. Memoires de l'Institut de Geologie du Bassin d'Aquitaine, No.7, 1974.

Papers on hydrology and suspended sediment transport in the estuary-shelf system; cohesionless sediment transport in the estuary-shelf system; present day sediments and facies distribution; Halocene and ancient analogues and evolution of the estuary-shelf interface; and methodology for assessing sedimentary processes; miscellaneous subjects. Bibliographies.

Isfeld, E.O., Hay, D., and Rossouw, J. Field and Model Studies on a Siltation Problem in the Fraser River. Proceedings of the First Canadian Hydraulics Conference, held at the University of Alberta, May 10 & 11, 1973, p.44-63. (See annotation in Section VI.)

Jackson, H.W. Estuary Studies (161.3) (Training Manual). U.S. Environmental Protection Agency, Cincinnati, Ohio, September 1972. (See annotation in Section IV.)

Jacobs, M.L. Salinity and Sedimentation Study -- Cooper River Rediversion, Charleston, South Carolina. WATER RESOURCES BULLETIN, vol.8, No.1, p.87-92, February 1972. (See annotation in Section III.)

Jeane, G.S., II, and Pine, R.E. Environmental Effects of Dredging and Spoil Disposal. WATER POLLUTION CONTROL, vol.47, No.3, p.553-561, March 1975. (See annotation in Section V.)

John, E.J., and Cheryan, K.P. Geomorphological Studies of the Estuary of River Netravati near Mangalore. Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, Copenhagen, Denmark, vol.II, 1975, Chapter 76 (p.1304-1318).

A number of factors such as wave conditions, tides, river flows, sediment charge, and ocean currents affect the features of an estuary. The understanding of the morphology of an estuary is essential on purely scientific considerations as well as applied to harbors. An attempt is made to study these interrelated and unsteady features and their combined effect on an estuary qualitatively. The estuary selected for the study is the one near Mangalore on the west coast of India at latitude 12° 51' north and longitude 74° 50' east, where two rivers, viz., river Netravati and river Gurpur meet together and join the sea. An effort is made to analyze the changes in the estuary in terms of prevailing wave conditions, river flows and sediment transport. References (7 items).

Johnson, J.W. Bolinas Lagoon Inlet, California. U.S. Army Corps of Engineers, Coastal Engineering Research Center, Miscellaneous Paper No.3-74, May 1974; University of California, Hydraulic Engineering Laboratory, HEL 24-15, May 1974.

The hydraulic and sedimentary characteristics of tidal inlets on sandy coasts have long been of interest to engineers involved in harbor design and maintenance. O'Brien, in a study of west coast inlets, proposed a relationship between the minimum inlet area below mean sea level and the tidal prism. Other investigators in recent years have proposed similar relationships. A reanalysis of data from inlets on U.S. coasts, by O'Brien, resulted in a later observation; he believed that the equilibrium relationship between inlet area and tidal prism as he originally proposed seemed to be a first approximation only and that the next effort should be for quantitative understanding of deviations from the approximation. If the flow area is determined by the tidal prism, then this area is in constant process of the adjustment because the tide range, and the related tidal prism, varies continually. The Bolinas Bay-Bolinas Lagoon system is a natural laboratory in which a large amount of data have been compiled on hydrography, wave action, tidal hydraulics, sediment transport and sedimentation, and the ecosystem. However, the data is insufficient to adequately define the importance of the inlet area and tidal prism. The source, nature and availability of data on the Bolinas Lagoon inlet are summarized as a guide to possible future studies at Bolinas, and at other inlets. Literature Cited (41 items).

Judge, C.W. Use of the Radioisotopic Sand Tracer (RIST) System. Coastal Engineering Research Center, Technical Memorandum

No.53, June 1975. (See annotation in Section VII.)

Kappa, S. How to "Irrigate a Harbor." WORLD DREDGING & MARINE CONSTRUCTION, vol.12, No.9, p.48-50, September 1976. (See annotation in Section V.)

Kérisel, T. Aménagement de l'estuaire de la Seine. Approfondissement du chenal d'accès au port de Rouen (Development of the Seine Estuary. Increasing the Depth of the Shipping Channel to the Port of Rouen). LA HOUILLE BLANCHE, vol.29, No.1/2, p.55-66, 1974. (In French.) (See annotation in Section VI.)

Kestner, F.J.T. The Loose-Boundary Regime of the Wash. Reprint from THE GEOGRAPHICAL JOURNAL, vol.141, Part 3, p.388-414, November 1975.

Paper describes and analyzes the accretional and erosional processes in the channels and on the foreshore of the Wash. The prerequisite for accretion is the continual circulation of large quantities of sediment, moving to and fro with the tides, which, in the absence of man-made interference or natural catastrophe, is essentially in dynamic balance (regime). On the foreshore this sediment circulation takes place mainly in the creeks. After bank-full stage, the silty and very fine sand fractions of the sediment flux leave the creeks and spread over the foreshore; but only where this sediment belt enters, on the landward side, the umbra of low foreshore velocities cast in front of it by a newly constructed reclamation embankment, does the sediment remain to cause accretion. Elsewhere, scour continues to remove the sediment from the foreshore and the deposits are only transient. The resulting cusp-pattern of the salt-marsh edge around the margin of the Wash makes this mechanism of the foreshore accretion visible. Along the landward margin of the foreshore this accretional process is only marginal, but this is not true of the similar process of accretion along the sides of channels. Here, the rate of accretion is high, because the rate of supply of the accreting material through the channels is high. This accretional process along the sides of the channels is an integral and important constituent of the estuarine environment into which any engineering work must be fitted, and it is essential that in designing any future work this factor should be taken into account. References (11 items)

King, D.B., and Shemdin, O.H. Modeling of Inlet-Bay Systems in Relation to Sand Trapping. Symposium on Modeling Techniques, 2nd Annual Symposium of the Waterways, Harbors and Coastal Engineering Division of ASCE, San Francisco, California, September 3-5, 1975, vol.II, p.1623-1637. (See annotation in Section VI.)

Kirby, C.J., Keeley, J.W., and Harrison, J. An Overview of the Technical Aspects of the Corps of Engineers National Dredged Material Research Program. In: Estuarine Research, Volume II: Geology and Engineering, edited by L. Eugene Cronin, Academic Press, Inc., New York, 1975, p.523-535. (See annotation in Section V.)

Klemas, V. Remote Sensing of Coastal Wetland Vegetation and Estuarine Water Properties. Estuarine Processes; Volume II, Circulation, Sediments, and Transfer of Material in the Estuary, edited by Martin Wiley. New York, Academic Press, 1977, p.481-493. (See annotation in Section VII.)

Klemas, V., Otley, M. Wethe, C., et al Monitoring Coastal Water Properties and Current Circulation with Spacecraft Second Joint Conference on Sensing of Environmental Pollutants, Washington, D.C., December 10-12, 1973, p.344-354. (See annotation in Section VII.)

Knebel, H.J., Conomos, T.J., and Commeau, J.A. Clay-Mineral Variability in the Suspended Sediments of the San Francisco Bay System, California. JOURNAL OF SEDIMENTARY PETROLOGY, vol.47, No.1, p.229-236, March 1977.

Semiquantitative determinations of the clay-mineral composition have been made on nearly synoptic samples of surface suspended sediments collected seasonally throughout the San Francisco Bay system. The relative amounts of chlorite + kaolinite are generally highest in the northern reach of the system, whereas illite is dominant in the southern reach. The proportion of montmorillonite is low throughout the bay. Time-series and replicate samples collected at individual stations show that the difference in clay-mineral content between reaches is real and reflects a change in the source of clay-mineral particles within the bay. The Sacramento-San Joaquin river system supplies the northern reach, whereas

most clay-mineral particles come from resuspension by waves and tidal currents in the southern reach. Analyses of bottom sediments and the spatial variability in the northern reach suggest that the relationship between the abundance and sources of clay minerals may, in turn, be a function of particle size. This study demonstrates the utility of suspended clay minerals in the interpretation of sediment-dispersal patterns in estuaries. References (27 items).

Kniess, H.-G. Eiderdamm. Wiederauffüllung von Baggerlöchern im Watt (Eiderdam. Resedimentation of Sandy Wadden Areas After Dredging). Mitteilungsblatt der Bundesanstalt für Wasserbau, No.40, December 1976, p.9-22. (In German.)

In the Eider-estuary at the German North Sea Coast large quantities of sand were dredged for construction works from 1967 to 1972. Three large holes of 0.6 to 2.0 million m^3 of volume, 25 m of depth and 200.00 m^2 of surface were left behind. These three pits were situated in or nearby tidal channels and were monitored until 1975. The resedimentation of the pits could be studied as a natural process in relation to transportation and sedimentation of sand in wadden areas. References (6 items).

Knoth, J.S., and Nummedal, D. Longshore Sediment Transport Using Fluorescent Tracer. Coastal Sediments '77, 5th Symposium of the Waterway, Port, Coastal and Ocean Division of ASCE, Charleston, South Carolina, November 2-4, 1977, p.383-398. (See annotation in Section VII.)

Komar, P.D. Relative Quantities of Suspension Versus Bed-Load Transport on Beaches. JOURNAL OF SEDIMENTARY PETROLOGY, vol.48, No.3, p.921-932, September 1978.

Uncertainty and debate have existed as to whether suspension or bed-load transport is most important in the longshore movement of sands on beaches. The evidence pertaining to this fundamental question is examined. A model based on measured concentrations of suspended sediments in the surf zone indicates that the suspended load comprises some 25 percent or less of the total drift, the bed-load forming the remaining 75 percent. Such estimates are obtained even when all approximations and assumptions made in developing the model are made in favor of the estimate of the suspension load. An examination of the relative rates of longshore movements of sand tracer grains as compared to the longshore currents indicates that the sand grains lag far behind the water flow. This indicates not only that suspension transport must be small, but also that our 25 percent upper estimate of suspension transport in the model must be revised downward, possibly to less than 10 percent. Other evidence is also presented that indicates the suspension load is much less significant than the bed-load transport on beaches. References (30 items).

Krone, R.B., and Ariathurai, R. Application of Predictive Sediment Transport Models. In: Dredging: Environmental Effects & Technology; Proceedings of WODCON VII, San Francisco, California, July 10-12, 1976, p.259-272. (See annotation in Section VI.)

Kuo, A.Y., Nichols, M., and Lewis, J. Modeling Sediment Movement in the Turbidity Maximum of an Estuary. Virginia Polytechnic Institute and State University, Blacksburg, Virginia, Water Resources Research Center, Bulletin No.111, June 1978. (See annotation in Section VI.)

Lavelle, J.W., and Thacker, W.C. Effects of Hindered Settling on Sediment Concentration Profiles. JOURNAL OF HYDRAULIC RESEARCH, vol.16, No.4, p.347-355, 1978.

Suspended sediment distributions which take into account concentration-dependent settling velocities have been derived. The distributions have been compared to and have been found to be in good agreement with the high concentration data of Einstein and Chien. The analysis shows that concentrations at the sediment bed in the Einstein-Chien data are close to those of saturated sediments, which leads to the suggestion that the reference level in the distributions always be taken at the bed where the reference concentration is flow independent. A suspended sediment distribution constructed in this way guarantees a reasonable value for concentrations near the bed and depends on two diffusivity parameters which the Einstein-Chien concentration data indicate are related. Bibliography (13 items).

Lee, T.N., and Rooth, C. Water Movements in Shallow Coastal Bays and Estuaries. University of Miami Sea Grant Program, Coastal Zone Management Bulletin Number 3, January 1973. (See annotation in Section I.)

Lepetit, J.-P. Stabilité du chenal d'accès au nouvel avant-Port de Dunkerque (Stability of the Access Channel of the New Outer-Harbour of Dunkerque). Proceedings, XVIth Congress of the International Association for Hydraulic Research, Sao Paulo, Brazil, July 27 to August 1, 1975, vol.1, Paper A28. (In French.) (See annotation in Section VI.)

Lespinc, E. Aménagement de l'estuaire de la Gironde (Development of the Gironde Estuary). LA HOUILLE BLANCHE, vol.29, No.1/2, p.71-78, 1974. (In French.) (See annotation in Section VI.)

Lewis, A.J., and MacDonald, H.C. Significance of Estuarine Meanders Identified from Radar Imagery of Eastern Panama and Northwestern Colombia. MODERN GEOLOGY, vol.1, No.3, p.183-196, 1970. (See annotation in Section VII.)

Love, P. Estuary & Foreshore Planning in Christchurch. SOIL & WATER, vol.14, No.5, p.18-19, October 1978. (See annotation in Section V.)

Lucas, A.H., and Cathers, B. Navigable Harbour Entrances Analysed by Hydraulic Models. Proceedings, XVIth Congress of the International Association for Hydraulic Research, Sao Paulo, Brazil, July 27 to August 1, 1975, vol.1, Paper A17. (See annotation in Section VI.)

Ludwick, J.C. Tidal Currents, Sediment Transport, and Sand Banks in Chesapeake Bay Entrance, Virginia. In: Estuarine Research, Volume II: Geology and Engineering, edited by L. Eugene Cronin, Academic Press, Inc., New York, 1975, p.365-380.

Taking the mean over all stations in the entrance area, and with reference only to a level 100 cm above the bed, tidal currents at ebb and flood strength are nearly equal in speed and average 42 cm/sec. Taking individual stations, ebb maximum is 79 cm/sec; flood maximum is 66 cm/sec; however, at more than half the observation stations, maximum flood speed and duration exceed maximum ebb speed and duration. If transport rate of bed sediment is proportional to stream power, $\tau_0 u_{100}$, where τ_0 is shear stress at the bed and u_{100} is current speed 100 cm above the bed, then at 19 of 24 stations, ebb-directed sediment transport exceeds flood-directed sediment transport. Much of the longer flood is incompetent and the greater ebb shear stress more than offsets larger flood speeds. Net sediment transport is directed landwards only in parts of channels and in dead-end sinuses re-entrant into shoals and open to flood currents. In Chesapeake Bay entrance, a wide entrance of moderate tidal range, net sediment transport at the headlands is directed seaward. Individual shoals within the entrance are bounded on one side by a net sediment transport to seaward and on the other side by a net sediment transfer to landward. Ebb deltas and flood deltas occur in alternate succession across the entrance with four to five of the former and three to four of the latter. There is also an interior flood delta found where ebb-directed sediment is interdicted and swept landwards in a flood-dominated channel. References (14 items).

Ludwick, J.C. Variations in Boundary Drag Coefficient in the Tidal Entrance to Chesapeake Bay, Virginia. Institute of Oceanography, Old Dominion University, Norfolk, Virginia, Technical Report No.19, August 1974. (See annotation in Section I.)

Masquet, J.-F. Aménagement de l'estuaire de la Loire (Development of the Loire Estuary). LA HOUILLE BLANCHE, vol.29, No.1/2, p.79-89, 1974. (In French.) (See annotation in Section V.)

May, E.B. Environmental Effects of Hydraulic Dredging in Estuaries. ALABAMA MARINE RESOURCES BULLETIN, No.9, p.1-85, April 1973. (See annotation in Section V.)

McDowell, D.M., and O'Connor, B.A. Hydraulic Behaviour of Estuaries. New York, John Wiley, 1977. (See annotation in Section I.)

McGregor, R.C. The Influence of Channel Shape on Shoaling in Tidal Estuaries Geophysical Journal of the Royal Astronomical Society, vol.36, No.3, p.599-606, March 1974.

The non-periodic equations which govern tidal flow in estuaries are solved for a channel of arbitrary cross-section. The solution, which relates all the principle parameters associated with estuarial flow to the location of the zeros, shows that with data appropriate to the River Humber the self-flushing effect of deep channels can cause the shoaling point to vary some 11 km at different points across the estuary. The prediction of the lateral

location of the sedimentation is very good. References (10 items).

McManus, J. Estuarine Development and Sediment Distribution, with Particular Reference to the Tay. The Royal Society of Edinburgh, *Proceedings, Section B.*, vol.71, Parts 2/4, p.97-113, 1972.

Estuarine development was contemporaneous with the onset of glaciation. In the Tay estuary fluvial erosion dominated the downcutting, with minor glacial modification; in the Forth estuary glacial scouring dominated the erosion of rockhead. Extensive subsurface exploration in connection with road improvement and foundations for bridge building and electricity pylon construction have yielded information on the fill of the Tay and Earn valleys. In addition to geophysical investigations the surveys include boreholes along a 20 km long section from Kinfauns to Longforgan, revealing deposition of lodgement tills followed by Arctic Clays, believed to have been deposited partly from floating ice. Above it are coarse sands and gravels, perhaps outwash deposits. Both were deeply dissected during a fall of sea level associated with a channel cut to -37 m O.D. at Dundee. Erosion and marine planation during lowered sea levels produced laterally extensive buried gravels. A rise of sea level led to burial of the eroded surface by early estuarine sediments which become finer upwards and terminate in peats, dated at 8500 B.P. Further erosion was followed by a second phase of estuarine sedimentation. This produced the coarse deposits whose terminal peats accumulated at 5500 B.P. The modern estuarial deposits partly bury those of the two preceding estuaries, which exert a major control on the migrations and depth of the modern channels. References to Literature (30 items).

McNair, E.C., Jr. Model Materials Evaluation; Sand Tests; Hydraulic Laboratory Investigation. U.S. Army Corps of Engineers, General Investigation of Tidal Inlets, GITI Report 7, June 1976. (See annotation in Section VI.)

Meade, R.H. Landward Transport of Bottom Sediments in Estuaries of the Atlantic Coastal Plain. JOURNAL OF SEDIMENTARY PETROLOGY, vol.39, No.1, p.222-234, March 1969.

The estuaries of the Atlantic Coastal Plain, which are the mouths of rivers drowned during the latest eustatic rise in sea level, are being filled with sediment. River-borne sediment is partially trapped in the estuaries by the predominantly landward flow of estuarine bottom waters. The main evidence of this are measurements of the sediment flux (suspended-sediment concentration and water velocity measured at intervals of depth and through tidal cycles) that show sediment being moved progressively landward along the bottom. Comparisons of the loci of sediment deposition and the patterns of water circulation show that sediment accumulates in estuaries near the upstream limit of landward bottom flow. The movement of sands into the mouths of the larger estuaries from the continental shelf and nearby beaches is also suggested by several other lines of evidence. Bottom waters of the continental shelf move progressively into the mouths of estuaries, and they presumably carry bottom sediments with them. Beach sands move toward and into the mouths of some estuaries at rates of several hundred thousand cubic meters per year. And distinctive mineral components in the lower reaches of estuaries suggest that the bottom sediments were derived from offshore. The rates of filling of the estuaries have been different in the northern and southern parts of the Coastal Plain. The large northern rivers carry disproportionately small loads of sediment that have not yet filled the deep valleys which were cut during the ice ages. The southern rivers carry larger sediment loads relative to the sizes of their valleys, and consequently their estuaries are mostly filled with sediment. References (65 items).

Meade, R.H. Net Transport of Sediment Through the Mouths of Estuaries: Seaward or Landward? Paper from International Symposium on Interrelationships of Estuarine and Continental Shelf Sedimentation, Bordeaux, France, 9-14 July 1973. Reprint from Memoires de l'Institut de Geologie due Bassin d'Aquitaine, No.7, p.207-213, 1974.

The drowned river valleys and other semi-enclosed embayments on the middle Atlantic coast of the United States between Cape Cod and Cape Lookout constitute one of the world's largest and best-studied assemblages of estuaries. Natural sources of modern sediments in these estuaries, and of the sediments on the wide continental shelf that adjoins them, are: 1) rivers, 2) shorelines (those in the estuaries as weli as those facing the open sea), and 3) older bottom sediments on the shelf. Do the rivers and estuaries supply more sediment to the shelf than the shelf supplies to the estuaries? Evidences for transport of sediment onto the shelf from estuaries are: 1) net seaward drift of surface waters in

estuaries and across the shelf, 2) plumes of turbid water that emerge from estuaries into the shelf, and 3) measurements that suggest a net seaward transport of sediment through the mouth of Delaware Bay. Evidences of transport of shelf sediment into estuaries are: 1) net landward drift of bottom waters on the outer half of the shelf and in the estuaries, along with net longshore drift toward the mouths of the estuaries, 2) accumulation of fine sediment in estuaries in contrast with the prevalence of coarser relict material on the shelf, and 3) mineral compositions of estuarine sediments (and suspended sediment in shelf waters) that correspond more closely to older shelf sediments than to sediments being carried by inflowing rivers. Although the conclusion is by no means certain, the evidence that is presently available gives more support to a net landward movement of sediment from the shelf into the estuaries. References (24 items).

Mehta, A.J., and Christensen, B.A. Incipient Sediment Motion in Entrances with Shell Beds. In: Rivers '76; Symposium on Inland Waterways for Navigation, Flood Control and Water Diversions; 3rd Annual Symposium of the Waterways, Harbors and Coastal Engineering Division of ASCE, Colorado State University, Fort Collins, August 10-12, 1976, vol.II, p.960-977, 1976. (See annotation in Section VI.)

Mehta, A.J., and Hou, H.S. Hydraulic Constants of Tidal Entrances II: Stability of Long Island Inlets. Coastal and Oceanographic Engineering Laboratory, University of Florida, Technical Report No.23, November 1974.

The susceptibility of a tidal inlet to closure involves a consideration of two opposing agencies, namely (a) the onshore wave energy which tends to drive littoral material towards the entrance, and (b) the tidal flow which attempts to scour this material to keep the entrance channel open. This concept has been explored with reference to the stability of the inlets on the south shore of Long Island. A generalized criterion for stability is proposed, and it is found that this criterion can be used to classify inlets ranging in size from a laboratory model to large natural entrances. References (37 items).

Mehta, A.J., and Partheniades, E. On the Depositional Properties of Estuarine Sediments. Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, Copenhagen, Denmark, vol.II, 1975, Chapter 72 (p.1232-1251).

The depositional characteristics of flocs of fine cohesive sediments in a turbulent flow field differ distinctly from those of a cohesionless material such as sand. This difference exists because the floc size and shear strength distributions depend on the sediment type as well as the flow condition itself; consequently, the problem of the depositional behavior of these flocs is rather complex, and not easily amenable to analytic treatment. The present basic experimental study was carried out in a specially designed annular channel. The derived laws of deposition in relation to the time-rates as well as the steady-state concentrations are described and discussed. The reanalyzed results of other limited investigations agree well with the result of the study. References (10 items).

Migniot, C. Etude comparative du taux d'envasement dans différentes zones de l'estuaire de la Loire (Comparative Study of Silting Rates in Various Parts of the Loire Estuary). LA HOUILLE BLANCHE, vol.29, No.1/2, p.137-147, 1974. (In French.)

It has been observed that monthly silting rates in various parts of the Loire estuary are apt to vary from 1.50 m to less than 0.10 m. Orders of magnitude of observed silting rates are stated for various sites and an attempt is made to relate them to local hydraulic conditions. Then, attention is drawn to the choice of suitable sites for a deep-water zone, a high-tide berth and a dock in an estuary. With discussion.

Miller, G.H., and Berg, D.W. An ERTS-1 Study of Coastal Features on the North Carolina Coast. U.S. Army, Corps of Engineers, Coastal Engineering Research Center, Miscellaneous Report No.76-2, January 1976. (See annotation in Section VII.)

Moes, J. Stability of Small Estuary Mouths. Proceedings, XVIth Congress of the International Association for Hydraulic Research, São Paulo, Brazil, July 27 to August 1, 1975, vol.1, Paper A11. (See annotation in Section VI.)

Mohr, A.W. Energy and Pollution Concerns in Dredging. Journal of the Waterways, Harbors and Coastal Engineering Division, Proc. ASCE, vol.101, No.WW4, p.405-417, November 1975. (See annotation in Section V.)

Murray, S.P., and Wiseman, W.J., Jr. Current Dynamics and Sediment Distribution in the West Mississippi Delta Area. Coastal Studies Institute, Center for Wetland Resources, Louisiana State University, Baton Rouge, A Collection of Reprints, September 1976, Technical Report No.208. Reprint from Conference on Marine and Freshwater Research in Southern Africa, July 1976.

The dynamical oceanography of the coastal bight west of Southwest Pass, an area extending roughly 50 km offshore and 70 km alongshore, was studied over the hydrologic year 1973-1974. Analysis of current observations from moored current meters and monthly anchor stations isolated clockwise-rotating tidal currents having amplitudes of 10-30 cm/sec, depending on location and vertical density gradients. Extremely strong tidal currents in the vicinity of Southwest Pass appear to be related to the early arrival of high water locally. Current profiles at the anchor stations often show significant vertical shear in speed and direction which is probably controlled by the density stratification. The spatial pattern of the tidal currents consists predominantly of reversing alongshore flow with significant shear in the onshore-offshore direction. Drogue tracks, combined with satellite imagery and surface salinity patterns, frequently show a trapped vortex west of the delta with onshore flows in the western extremity of the study area. Conversely, monthly hydrographic cruises on a dense grid suggest that heavy Gulf water persistently intrudes at depth into the central core of the curved bight. Although subject to strong dispersive processes by the marked spatial variability in the tidal current field, the sediment pattern nevertheless appears to be largely controlled by the mean current field produced by seasonal wind and river discharge effects. References (2 items).

Nasner, H. Prediction of the Height of Tidal Dunes in Estuaries. Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, Copenhagen, Denmark, vol.II, 1975, Chapter 60 (p.1036-1050).

In this paper prototype data of echo soundings of tidal dunes are analyzed. A good relation between the fresh water discharge and the sand wave migration velocity in the upper part of a tidal river could be determined. The limitation of the dune heights as a function of the mean current velocities over the crests and the bed material characteristics is presented. States of equilibrium are described by dimensionless parameters and the latter compared with model tests. References (5 items).

National Research Council, Geophysics of Estuaries Panel. Estuaries, Geophysics, and the Environment. National Academy of Sciences, Washington, D.C., 1977. (See annotation in Section IV.)

Nece, R.E., and Lowthian, R.A. Tidal Circulation Study, Proposed Southeast Harbor Development. Charles W. Harris Hydraulics Laboratory, Department of Civil Engineering, University of Washington, Seattle, Technical Report No.47, January 1976. (See annotation in Section VI.)

Nerang River Entrance; A Mobile Bed Model. HYDRO DELFT, No.45, p.4-6, December 1976. (See annotation in Section VI.)

Nielsen, E. Feasibility of Coastal Morphological Models. Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, Copenhagen, Denmark, vol.II, 1975, Chapter 38 (p.663-684). (See annotation in Section VI.)

Nihoul, J.C.J., Ronday, F.C., Peters, J.J., et al. Hydrodynamics of the Scheldt Estuary. Hydrodynamics of Estuaries and Fjords; Proceedings of the 9th Liege Colloquium on Ocean Hydrodynamics, 1977, p.27-53. (See annotation in Section I.)

Nittrouer, C.A., and Sternberg, R.W. The Fate of a Fine-Grained Dredge Spoils Deposit in a Tidal Channel of Puget Sound, Washington. JOURNAL OF SEDIMENTARY PETROLOGY, vol.45, No.1, p.160-170, March 1975.

Fifteen thousand cubic meters of fine-grained sediment dredged from Olympia Harbor, Washington, were disposed at Dana Passage, a large tidal channel in Puget Sound, Washington. Water depth at the disposal site is 30 m; maximum tidal currents range from 110 cm/sec at the surface to 50 cm/sec at the bottom (measured 100 cm above the bed). Gravity coring, bottom photography, and diver measurements allowed delineation of the dimensions and nature of the spoils deposit. Four months after completion of disposal, 16% of the volume of sediment remained at the disposal site in a flat conical deposit (maximum thickness 70 cm, radius 60 m). The 84% loss represents sediment placed in suspension during disposal of the spoils, sediment eroded soon after disposal, and water lost during consolidation of the deposit. Selective

removal of fine-grained sediment and organic material caused the spoils deposit to be coarser (mean grain size 0.027 mm), and to have a lower total volatile content (4.1%) than the sediment originally dumped (mean grain size 0.014 mm; total volatile content 8.9%). After four months, loosely consolidated sediment had been removed from the deposit, and the consolidation of the remaining spoils provided sufficient cohesion to resist further erosion by the relatively strong bottom currents. The factors which control the stability of a fine-grained dredge spoils deposit are: (a) the amount of spoils disturbance (dilution) caused by the dredging and disposal techniques, (b) the water depth at the disposal site, and (c) the energy considerations of the bottom environment at the disposal site, e.g., strength of bottom currents. Dredging and disposal by techniques which minimize sediment disturbance, and disposal of spoils in shallow water and low energy environments are processes which maximize stabilization. References (34 items).

Noyce, J.R., Hutchinson,, J.M.R., Mann, W.B., et al. Development of a National Bureau of Standards Environmental Radioactivity Standard: River Sediment. Proceedings of the International Conference on Environmental Sensing and Assessment, Las Vegas, Nevada, September 14-19, 1975, vol.I.

The National Bureau of Standards has developed and produced a radioactivity standard of a fresh-water sediment for use especially in environmental radioactivity measurements around nuclear and coal-burning electric power plants. The radioactivities of 28 nuclides in the sediment have been measured, of which 10 are certified. The development and production of this new Standard Reference Material (SRM 4350) are discussed. References (21 items).

O'Brien, M.P. Notes on Tidal Inlets on Sandy Shores. U.S. Army Corps of Engineers, General Investigations of Tidal Inlets, GITI Report 5, February 1976. (See annotation in Section I.)

O'Connor, B.A. Sediment Intrusion in a Tidal Lock. Proceedings, XVIth Congress of the International Association for Hydraulic Research, São Paulo, Brazil, July 27 to August 1, 1975, vol.3, Paper C35. (See annotation in Section VI.)

O'Connor, B.A., and Zein, S. Numerical Modelling of Suspended Sediment. Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, Copenhagen, Denmark, vol.II, 1975, Chapter 65 (p.1109-1128). (See annotation in Section VI.)

Oertel, G.F. Ebb-Tidal Deltas of Georgia Estuaries. In: Estuarine Research, Volume II: Geology and Engineering, edited by L. Eugene Cronin, Academic Press, Inc., New York, 1975, p.267-276.

Configurations of tidal deltas are determined by the interactions between inlet tidal drainage and longshore currents in the near-shore zone. The tidal range along the Georgia shoreline is 2-3 meters and produces moderate to strong tidal currents adjacent to estuary inlets. Wave energy dissipates over a wide (11 kilometers), shallow (less than 10 meters) zone and attenuates significantly before it impinges on the shoreline. Therefore, along the Georgia coast, the zones adjacent to estuary inlets experience moderate-velocity to high-velocity tidal currents, whereas, the wind- and wave-induced longshore currents are generally buffered before they reach the shoreline. Tidal deltas, produced by the current interactions at tidal inlets, illustrate the predominant influence of inlet tidal drainage. The peripheral-shoal complexes of the tidal deltas have well-developed marginal shoals that are approximately 2 kilometers apart and parallel each other for approximately 5.5 kilometers seaward of the inlet. Distal shoals are poorly developed or absent. The marginal shoals on the south sides of these channels are elongate, triangular sand bodies that are broadest at their point of attachment to the barrier. Ephemeral spill-over channels and runnels transect these sand bodies at oblique angles. These channels help distribute the centrifugal flow of inlet drainage away from the entrance. On the north sides of the main axial channels, spill-over channels are deeply incised into the marginal shoals. One of these channels separates the marginal shoals from the barrier. References (12 items).

Oertel, G.F. Post Pleistocene Island and Inlet Adjustment Along the Georgia Coast. JOURNAL OF SEDIMENTARY PETROLOGY, vol.45, No.1, p.150-159, March 1975.

Holocene beach-ridge development has produced a sequential constriction of many of Georgia's tidal inlets. Inlet constrictions were produced as marginal spits encroached on both sides of many of Georgia's inlets. The constriction of the inlets appeared to be a response to retreating shorelines, seasonal reversals

in longshore sediment transport, localized flood channel deposition, and decreasing lagoonal tidal prisms caused by marsh deposition. While the inlets were contracting along their horizontal axes, they were expanding along their vertical axes. The slow retreat of the shoreline produced by the Holocene transgression was expressed by washover deposits in low-lying areas and bluff development in other areas. Sediment was transported away from the bluffs by longshore currents and was deposited in sand bodies on the margins of tidal inlets. Seasonally reversing longshore currents and flood-dominated channeling permitted accretion on both margins of many inlets. Reversing tidal currents produced sediment accumulations landward of the inlets and tidal deltas seaward of inlets. During the Holocene, the rising sea level produced expanding lagoonal tidal prisms and an increase in the volume of water exchanged through the inlet throats. The increased exchange through the inlet throats produced high velocity currents that eroded the floors of the channel (at the inlet throats) and scoured deep troughs into the underlying Pleistocene, Pliocene, and Miocene deposits. References (36 items).

Officer, C.B. Physical Oceanography of Estuaries. In OCEANUS, vol.19, No.5, p.3-9, Fall 1976. (See annotation in Section I.)

Officer, C.B. Physical Oceanography of Estuaries (and Associated Coastal Waters). New York, John Wiley, 1976. (See annotation in Section I.)

Ordonez, J.I. Modeling Sediment Deposition in a Tidal River. Symposium on Modeling Techniques, 2nd Annual Symposium of the Waterways, Harbors and Coastal Engineering Division of ASCE, San Francisco, California, September 3-5, 1975, vol.II, p.1347-1368. (See annotation in Section VI.)

Orme, A.R. Estuarine Sedimentation Along the Natal Coast, South Africa. University of California, Department of Geography, Los Angeles, Technical Report No.5, August 1974.

The character and materials of sedimentation in estuaries and lagoons along the 570 km Natal coast are described and analyzed. Sites examined include the Greater St. Lucia lagoon system with its 9 major contributing rivers, Richards Bay with its 2 main contributing rivers, and 28 rivers that discharge directly into the Indian Ocean without passing through an intermediate lagoonal filtering system other than their own estuaries. Discussion is based on field and remote sensing investigations and borehole data, and is supported by pertinent maps and cross-sections. The nature and processes of sedimentation along the Natal coast are representative of events along more than 2000 km of African coast from central Mozambique to eastern Cape Providence. Sedimentation reflects four groups of variables: watershed characteristics, especially drainage basin size and relief, and terrain erodibility as influenced by widespread saprolites and land-use practices; climate, especially the frequency and magnitude of summer thunderstorms; hydrology, especially variable runoff-precipitation ratios, stream velocity, discharge, and sediment loads; and the size and storage capacity of the estuaries and lagoons which reflect the dimensions of buried bedrock channels, flood scour and fill, and tidal effects. Buried bed-rock channels occur beneath major estuaries to depths exceeding -50 m below mean sea level, and often contain buried terraces. Smaller watersheds have proportionally smaller buried channels, reflecting less late Pleistocene downcutting. The two largest lagoons along the Natal coast at the close of the Flandrian transgression were the Greater St. Lucia Lagoon (1165 km^2) and Richards Bay (153 km^2). These have been reduced by sedimentation to 27% and 33% of their former area, respectively, and the processes of sedimentation appear to be accelerating at the present time. Fluvial deposits, ranging from large boulders to fine clays and typically dirty and rich in organic debris, occur throughout the estuaries but predominate in the inner areas. Lagoonal deposits, typically black organic silts and clays, accumulate toward the center of the lagoons and estuaries, or as backswamp deposits associated with reeds and mangroves to the side of the main channels. In shallow estuaries, lagoonal materials are commonly removed by major floods but in deeper embayments swamp facies survive from the Flandrian transgression. Marine deposits occur at depth beneath the larger estuaries, having been carried in by wave and tidal action during the transgression. Today, marine deposition is confined to the mouths of the estuaries, commonly as barrier beaches and spits whose sands are washed and blown over into the lagoons. These barriers are periodically destroyed by discharging floodwaters but are soon rebuilt by powerful longshore currents. The largest estuaries experience a range of up to 20 m between the highest flood levels and

the deepest scour troughs under present conditions. References (11 items).

Oviatt, C.A., and Nixon, S.W. Sediment Resuspension and Deposition in Narragansett Bay. ESTUARINE AND COASTAL MARINE SCIENCE, vol.3, No.2, p.201-217, April 1975.

Monthly samples of sediments deposited in traps at three locations in Narragansett Bay, Rhode Island, showed a gradient in sediment activity that increased from an annual mean of 20 ± 8.8 g m^{-2} day^{-1} at the head of the estuary to 51 ± 16.7 g m^{-2} day^{-1} at the mouth. Deposited materials were significantly higher in total organic matter, organic carbon and nitrogen than near surface sediments on the bottom. These parameters showed a gradient that decreased toward the mouth of the bay, with organic matter dropping from 14 ± 1 to 10 ± 1% of the dry weight deposited; carbon from 5.4 ± 0.9 to 3.4 ± 1.0%; and nitrogen from 0.6 ± 0.1 to 0.4 ± 0.1%. The annual mean C/N ratio was 8.2 in the lower bay and 8.7 in the upper bay. Deposited materials were dominated by particles in the silt size range from 4-60 μm and comprised for the most part resuspended bottom sediments rather than fresh inputs of material from the water column. References (64 items).

Owens, E.H. Barrier Beaches and Sediment Transport in the Southern Gulf of St. Lawrence. Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, Copenhagen, Denmark, vol.II, 1975, Chapter 69 (p.1177-1193).

Barrier islands and barrier beaches have developed across structurally controlled estuaries and embayments in the southern Gulf of St. Lawrence. The supply of sediments to the littoral zone and the subsequent accumulation of barrier deposits are a result of the reworking, transportation and longshore dispersal of sediments which are moved landward by tidal and wave-induced currents from the adjacent shallow sea floor. The size and stability of the barriers is controlled by the shoreline orientation. References (13 items).

Ozsoy, E. Flow and Mass Transport in the Vicinity of Tidal Inlets. Coastal and Oceanographic Engineering Laboratory, University of Florida, Gainesville, UFL/COEL/ TR-036, 1977. (See annotation in Section I.)

Palumbo, A.V., and Ferguson, R.L. Distribution of Suspended Bacteria in the Newport River Estuary, North Carolina. ESTUARINE AND COASTAL MARINE SCIENCE, vol.7, No.6, p.521-529, December 1978.

Numbers of suspended bacteria in the Newport River estuary, North Carolina, during June to December 1974, were determined by direct counts using acridine orange and epifluorescent illumination on 0.45 μm porosity cellulose acetate filters. Bacteria ranged from 1.95 to 18.4 million cells/ml and were more abundant in the low salinity water (<15°/oo) of the upper estuary than in the high salinity water (up to 34°/oo) of the lower estuary. The inverse linear distribution of bacteria with salinity in the lower estuary suggests conservative mixing of bacteria. Preliminary observations on the distribution of relative DOM concentrations and on heterotrophic activity also indicate that the bacteria in the lower estuary are relatively inactive compared to the bacteria in the upper estuary and that the upper estuary may be a source of bacteria to the system. References (37 items).

Parker, R.A. Spatial Patterns in a Nutrient Model. ECOLOGICAL MODELLING, vol.4, No.4, p.361-370, May 1978.

An exact solution is given for a partial differential equation description of plankton populations interacting with nutrients in a moving water mass. Eddy diffusion and exchange with an underlying layer are included. Results are examined over one spatial dimension using different constant velocities and diffusivity values. The influence of advection relative to diffusion varies, and several system parameters alter both the amplitude and frequency of plankton pulses. References (11 items).

Partheniades, E. Unified View of Wash Load and Bed Material Load. Journal of the Hydraulics Division, Proc. ASCE, vol.103, No.HY9, p.1037-1057, September 1977. (See annotation in Section VI.)

Pasenau, H. Giant and Mega Ripples in the German Bight and Studies of Their Migration in a Testing Area (Lister Tief). Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, Copenhagen, Denmark, vol.II, 1975, Chapter 59 (p.1025-1035).

In a lot of regions the bottom of the North Sea is covered with large ripple fields, especially in the estuaries and in the tidal channels. A great number of echo sounding profiles (29.500 n.m.) were evaluated to determine the boundaries of these areas and to describe the dimension of patterns. Special investigations of the hydrographic situation, the distribution of deposits and the migration of ripples under the influence of tidal currents only, were carried out in a testing area in the Lister Tief on 11 cruises since 1971. References (3 items).

Patel, B., Mulay, C.D., and Ganguly, A.K. Radioecology of Bombay Harbour -- A Tidal Estuary. ESTUARINE AND COASTAL MARINE SCIENCE, vol.3, No.1, p.13-42, January 1975. (See annotation in Section VIII.)

Pequegnat, W.E. Meiobenthos Ecosystems as Indicators of the Effects of Dredging. In: Estuarine Research, Volume II: Geology and Engineering, edited by L. Eugene Cronin, Academic Press, Inc., New York, 1975, p.573-583. (See annotation in Section VI.)

Percy, K.L., Bella, D.A., Sutterlin, C., et al. Descriptions and Information Sources for Oregon Estuaries. Oregon State University, Sea Grant College Program, May 1974. (See annotation in Section VIII.)

Physical and Biological Aspects of the Tay Estuary; A Symposium held in the Rooms of the Royal Society of Edinburgh, Edinburgh (Scotland), 5 December 1973. The Royal Society of Edinburgh, Proceedings, Section B, vol.75, Parts 1/2, 1975. (See annotation in Section VIII.)

Pickral, J.C., and Odum, W.E. Benthic Detritus in a Saltmarsh Tidal Creek. Estuarine Processes; Volume II, Circulation, Sediments, and Transfer of Material in the Estuary, edited by Martin Wiley. New York, Academic Press, 1977, p.280-292. (See annotation in Section VII.)

Pickrill, R.A. Effects of Boat Wakes on the Shoreline of Lake Manapouri. NEW ZEALAND ENGINEERING, vol.33, No.9, p.194-198, September 1978. (See annotation in Section VI.)

Pollution Criteria for Estuaries; Proceedings of the Conference held at the University of Southampton, July 1973; edited by P.R. Helliwell and J. Bossanyi. John Wiley & Sons, New York, 1975. (See annotation in Section IV.)

Pomeroy, L.R., Bancroft, K., Breed, J., et al. Flux of Organic Matter Through a Salt Marsh. Estuarine Processes; Volume II, Circulation, Sediments, and Transfer of Material in the Estuary, edited by Martin Wiley. New York, Academic Press, 1977, p.270-279.

To refine our knowledge of the functional aspects of salt marshes, we have undertaken a study of the transfers of organic matter from primary producers through consumers to CO_2 in terms of quality and quantity of carbon compounds. In addition to production of particulate material, we find sources of soluble carbon compounds which may be significant. These include losses from both living and dead macrophytes, primarily Spartina, from algae in water and sediments, from excretion and feces of consumers, and from biological processes in the sediments. Since Spartina detritus is relatively indigestible, much of the flux of organic matter to detritovores must involve conversion of particulate detritus to soluble compounds and their assimilation by microorganisms, which can then be consumed by detritovores. Some dissolved material accumulates as a film on the surface of the water and is formed into organic aggregates. Several lines of evidence suggest that microorganisms in the water actively assimilate dissolved organic material during the growing season. Microorganisms in the sediments, although they reside in a large pool of organic matter, appear to be substrate limited except near the sediment-water surface. Literature Cited (39 items).

Ponce, V.M., Garcia, J.L., and Simmons, D.B. Modeling Alluvial Channel Bed Transients. Journal of the Hydraulics Division, ASCE, vol.105, No.HY3, p.245-256, March 1979. (See annotation in Section VI.)

Pruter, A.T., and Alverson, D.L., Editors. The Columbia River Estuary and Adjacent Ocean Waters; Bioenvironmental Studies. University of Washington Press, Seattle and London, 1972. 868p. (See annotation in Section IV.)

Purpura, J.A., Beechley, B.C., Baskette, C.W., et al. Performance of a Jetty-Weir Inlet Improvement Plan. Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, vol.II,

1975, Chapter 86 (p.1470-1490). (See annotation in Section V.)

Ramming, H.-G. Numerical Investigations of the Influence of Coastal Structures upon the Dynamic Off-Shore Process by Application of a Nested Tidal Model. Hydrodynamics of Estuaries and Fjords; Proceedings of the 9th Liege Colloquium on Ocean Hydrodynamics, 1977, p.315-348. (See annotation in Section VI.)

Reid, G.K., and Wood, R.D. Ecology of Inland Waters and Estuaries. 2d ed. New York, Van Nostrand, 1976. 485p. (See annotation in Section VIII.)

Remote Sensing of the Environment; Part 2: Dynamics, A Bibliography with Abstracts. National Technical Information Service, NTIS/PS-78/0564, June 1978. (See annotation in Section VII.)

Renger, E., and Partenscky, H.-W. Stability Criteria for Tidal Basins. Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, Copenhagen, Denmark, vol.II, 1975, Chapter 93 (p.1605-1618).

The contribution deals with the morphologic examinations and calculations for a deep-water harbor which is to be constructed in the tidal flats of the Elbe estuary near the North Sea islands of Scharhörn and Neuwerk. An attempt is made to examine the stability of tidal channels (gullies) and tidal flats which may be disturbed to a greater or lesser extent by the various proposals for the connecting dike between the industrial area near the harbor and the coastline. The underlying logic for the determination of the equilibrium of the flats and the quantitative solution for the sand-balance is as follows: It has been shown in several empirical investigations that the increase of the relative volume of the tidal basin (V/V_{MLW}), referenced to the gully volume for MLW, can be determined as a simple function to the base ($\bar{a}$) logarithm of the geodetic elevation (z^*) between MLW and any higher contour level up to MHW. Furthermore it can be shown that (V_{MLW}) is also a function of the tidal drainage area (E). The base ($\bar{a}$) has been related to the size of the tidal drainage area (E), because this area is subject to considerable modification by offshore structures such as dikes and causeways. A comparison of the volumes of the tidal basins for the situation before and after construction can be made. This in turn leads to the sand balance which can be applied to the given and expected volumes of the tidal basin, so that the sand removed or added can be predicted. References (8 items).

Roberts, W.P., and Pierce, J.W. Deposition in Upper Patuxent Estuary, Maryland, 1968-1969. ESTUARINE AND COASTAL MARINE SCIENCE, vol.4, No.3, p.265-280, May 1976.

Urbanization leads to increased runoff and sediment discharge during construction as shown in a year-long study of the Patuxent River drainage basin during a period of intense development for housing. Although precipitation was only 80% of previous years, water discharge to the estuary was 2.4 times the average. A net upstream flux of suspended sediment indicated that all fluvial suspended sediment was deposited in the upper reaches of the estuary. Two areas of net deposition were separated by a central turbidity maximum, which fluctuated in position over a 10-km distance in response to high or "average" river discharge. During low river discharge, two turbidity maxima were observed; one, corresponding with the salt front; and the other, with a downstream constriction in the estuary channel. The average rate of deposition in the upper 50 km of the estuary was calculated to be 7.45 g cm^{-2} $year^{-1}$. If approximately 20% of the riverborne sediment was deposited between the tidal limit and the average position of the salt front, then 5.88 g/cm^2 were deposited during the study period, forming a layer with an average thickness of 3.7 cm. References (32 items).

Robinson, A.H.W. Cyclical Changes in Shoreline Development at the Entrance to Teignmouth Harbour, Devon, England. In: Nearshore Sediment Dynamics and Sedimentation, An Interdisciplinary Review, edited by J. Hails and A. Carr, John Wiley & Sons, London, 1975, Chapter 8 (p.181-200).

The cyclical pattern of change at the mouth of the Teign Estuary in Devon has been recognized for over a century. Previous studies have been of limited duration so it is not surprising that estimates of the cycle period have varied between wide limits, with a maximum of about 7 years. There are also conflicting views as to the relative efficacy of tidal currents and waves in bringing about the observed changes of bottom configuration. Since 1964 the morphology of the approaches to the estuary has been studied by mapping bank changes, tracing sediment movement and undertaking some

direct measurements of the operative processes. For the most part the approach has been geomorphological and deductive. In spite of some inherent limitations in the method adopted, knowledge gained from 10 years of observations makes it clear that the cyclical pattern is both complex and irregular. Even in the small area of the estuary approach there are distinct current- and wave-dominated environments. References (8 items).

Ruzecki, E.P., and Ayers, R. Suspended Sediments near Pier 12, Norfolk Navy Base, on 26 June and 15 September 1973. Virginia Institute of Marine Science, Data Report No.11, October 1974.

Results of two suspended sediment studies near Norfolk Navy Base Pier 12 are given. The studies were conducted during one tidal cycle on both 26 June and 15 September 1973. The following parameters were measured at five stations in the vicinity of the pier: suspended sediment, water temperature, salinity and density, current speed and direction.

Sager, R.A., and Seabergh, W.C. Modeling Sediment Movement for Masonboro Inlet. Symposium on Modeling Techniques, 2nd Annual Symposium of the Waterways, Harbors and Coastal Engineering Division of ASCE, San Francisco, California, September 3-5, 1975, vol.I, p.274-293. (See annotation in Section VI.)

Scheidegger, K.F., and Phipps, J.B. Dispersal Patterns of Sands in Grays Harbor Estuary, Washington. JOURNAL OF SEDIMENTARY PETROLOGY, vol.46, No.1, p.163-166, March 1976.

A heavy mineral study in Grays Harbor, Washington, was undertaken to determine the sources and dispersal patterns of sands in the estuary. Using conventional heavy mineral analysis three provinces of sand deposition were clearly outlined: marine, mixed and river. Sands with a heavy mineral suite characteristic of the marine province extend more than 11 km into the estuary, suggesting that the lower part of the estuary is being filled by marine sands. The results of this study suggest that routine heavy mineral analysis of sands in estuaries may have much practical importance to those interested in predicting the long term directions of dispersal of sands that may be dumped in the estuary as a consequence of dredging activity. References (12 items).

Schubel, J.R. Effects of Agnes on the Suspended Sediment of the Chesapeake Bay and Contiguous Shelf Waters. In The Chesapeake Research Consortium, Inc., The Effects of Tropical Storm Agnes on the Chesapeake Bay Estuarine System, CRC Publication No.54, November 1976, p.179-200.

The flooding rivers discharged massive amounts of suspended sediment into the Chesapeake Bay estuarine system. In the 10-day period, 21-30 June 1972, the Susquehanna discharged more than 31×10^6 metric tons of suspended sediment into the Bay. Its annual input during most years is only $0.5\text{-}1.0 \times 10^6$ metric tons. Concentrations of suspended sediment throughout much of the Chesapeake Bay estuarine system were higher than any previously reported. During the period of peak riverflow the upper Bay was characterized by a marked longitudinal gradient of suspended sediment. On 26 June 1972, two days after the Susquehanna crested, the concentration of suspended sediment in the surface waters dropped from more than 700 mg/ℓ at the head of the Bay (Turkey Point) to 400 mg/ℓ at Tolchester, and to 175 mg/ℓ at the Annapolis Bay Bridge. Concentrations of suspended sediment in the upper Bay remained anomalously high for about a month after Agnes. In the middle and lower reaches of the Bay concentrations of suspended sediment were 2-3 times higher than "normal," and the outflow from the Bay could be traced as a band of low salinity, turbid water that turned south and flowed along the Virginia and Carolina coasts. Literature Cited (11 items).

Schubel, J.R., and Carter, H.H. Suspended Sediment Budget for Chesapeake Bay. Estuarine Processes; Volume II, Circulation, Sediments, and Transfer of Material in the Estuary, edited by Martin Wiley. New York, Academic Press, 1977, p.48-62.

The Susquehanna is the only river that discharges directly into the main body of the Chesapeake Bay. All the other rivers flow into tributary estuaries and most of their sediment loads are entrapped within these estuaries. During periods of high riverflow the Susquehanna dominates the upper 20-30 km of the Bay; the net flow and sediment transport are seaward at all depths, and there is a marked downstream decrease in suspended sediment. With subsiding riverflow, a turbidity maximum is formed in the upper reaches of the Bay. In the middle and lower reaches of the Bay, shore erosion is not only a major source of inorganic sediment it may be the largest single source. The

distributions of suspended sediment along the axis of the entire Bay are presented for a twelve month period in 1969-1970. These data, and others, were used to formulate a single-segment model of the main body of the Bay that indicates that there is a net movement of sediment into the Bay from the ocean, and that the tributary estuaries are sinks for suspended sediment in the Bay. References (28 items).

Seabergh, W.C. Simulation of Sediment Movement for Masonboro Inlet, North Carolina. In: Estuarine Research, Volume II: Geology and Engineering, edited by L. Eugene Cronin, Academic Press, Inc., New York, 1975, p.111-127. (See annotation in Section VI.)

Segar, D.A., and Cantillo, A.Y. Some Considerations on Monitoring of Trace Metals in Estuaries and Oceans. Proceedings of the International Conference on Environmental Sensing and Assessment, Las Vegas, Nevada, September 14-19, 1975, vol.I. (See annotation in Section IV.)

Shearin, K.K., and Machemehl, J.L. River Delta Computer Simulation Model (SIMUDELT). Symposium on Modeling Techniques, 2nd Annual Symposium of the Waterways, Harbors and Coastal Division of ASCE, San Francisco, California, September 3-5, 1975, vol.I, p.240-253. (See annotation in Section VI.)

Sherk, J.A., O'Connor, J.M., and Neumann, D.A. Effects of Suspended and Deposited Sediments on Estuarine Environments. In: Estuarine Research, Volume II: Geology and Engineering, edited by L. Eugene Cronin, Academic Press, Inc., New York, 1975, p.541-558.

Static bioassays conducted with fuller's earth suspensions on white perch, spot, silversides, bay anchovies, mummichogs, striped killifish, and menhaden showed that significant mortality in five of the seven species could be caused by concentrations of natural suspended solids typically found in estuarine systems during flooding, dredging, and spoil disposal. Lethal concentrations ranged from a low of 0.58 g/l fuller's earth (24 hr LC_{10}) for silversides to 24.5 g/l fuller's earth (24 hr LC_{10}) for mummichogs. Fishes were classified as either tolerant (24 hr LC_{10} > 10 g/l) sensitive (24 hr LC_{10} < 10 > 1.0 g/l), or highly sensitive (24 hr LC_{10} < 1.0 g/l) to fuller's earth. Generally, bottom-dwelling species were most tolerant to suspended solids; filter feeders were most sensitive. Early-life stages were more sensitive to suspended solids than adults. Exposure to sublethal fuller's earth concentrations significantly increased hematocrit value, hemoglobin concentration, and erythrocyte numbers in the blood of white perch, hogchokers, and striped killifish, but not of spot and striped bass. Evidence of O_2-CO_2 transfer interference during exposure to sublethal concentrations of fuller's earth was exhibited by the gills of white perch, which showed tissue disruption and increased mucus production. Suspensions of fuller's earth, fine sand, and Patuxent River silt (<60 mg/l) caused significant reductions in ingestion of radio-labelled ($NaH^{14}CO_3$) Monochrysis lutheri by the copepods Eurytemora affinis and Acartia tonsa. Differences in uptake between the two species may have been related to their different life habitats, although both are non-selective suspension feeders. References (30 items).

Sherk, J.A., Jr., O'Connor, J.M., and Neumann, D.A. Effects of Suspended Solids on Selected Estuarine Plankton. U.S. Army Coastal Engineering Research Center, Miscellaneous Report No. 76-1, January 1976.

A 3-year laboratory study identified biological components of selected populations of estuarine organisms which were most sensitive to the effects of particle size and concentrations of (a) suspended mineral solids similar in size to sediments likely to be found in, or added to, estuarine systems in concentrations typically found during flooding, dredging, and disposal of dredged material, and (b) natural sediments in identical experiments. Carbon assimilation by four species of phytoplankton was significantly reduced by the light attenuating properties of fine silicon dioxide suspensions. Ingestion of radioactively tagged food cells by two species of calanoid copepods was significantly reduced during exposure to suspensions of fuller's earth, fine silicon dioxide, and natural Patuxent River silt. This report provides baseline data for preproject decision-making based on concentration effects of different suspended sediments on selected typical estuarine plankton. Literature cited (35 items).

Sherk, J.A., O'Connor, J.M., Neumann, D.A., et al. Effects of Suspended and

Deposited Sediments on Estuarine Organisms - Phase II. University of Maryland, C.B.L. Ref. No.74-20, March 1974. NTIS Report AD A011 372.

A three-year laboratory study identified biological components of selected populations of estuarine organisms that were most sensitive to the effects of particle size and concentration of: (1) suspended mineral soli similar in size to sediments likely to be found in estuarine systems in concentrations typically present during flooding, dredging, and disposal of dredged material; and (2) natural sediments in identical experiments. Significant mortality of estuarine fishes was demonstrated at these suspended solids concentrations. Early life states were more sensitive to suspended solids than adults were. Bioassays with natural sediments indicated that suspensions of natural muds affect fishes in the same way as suspensions of mineral solids do, but higher concentrations of natural material were required to produce the same level of response. Literature Cited, p.201-207.

Shideler, G.L. Physical Parameter Distribution Patterns in Bottom Sediments of the Lower Chesapeake Bay Estuary, Virginia. JOURNAL OF SEDIMENTARY PETROLOGY, vol.45, No.3, p.728-737, September 1975.

Bottom sediments within the lower Chesapeake Bay between the Potomac River and the Atlantic Ocean were analyzed for mud content, sand texture, organic content, and color. Parametric distribution patterns indicate a complex dispersal model, in which sediments are derived from multiple sources. The bay region between the Potomac and York Rivers appears to be an effective mud trap, with the central basin constituting a uniformly-colored mud depocenter, while the marginal zones are composed of multicolored residual sand deposits. The baymouth sector south of the York River is a multicolored sand province that constitutes an effective mud-bypass area. A regional belt of highly organic sediments occurs throughout the lower bay which reflects a zone of high benthonic shell concentrations. Sand textures suggest a composite fabric of modern equilibrium sediments, and palimpsest sediments that reflect an earlier hydraulic regime. The palimpsest sediments may represent Pleistocene fluvial deposits of the ancestral Susquehanna drainage system, and early Holocene paralic deposits generated during the bay's inundation. References (37 items).

Shultz, D.J. Stable Carbon Isotope Variations in Organic and Inorganic Carbon Reservoirs in the Fenholloway River Estuary and the Mississippi River Estuary. Ph.D. Dissertation, Florida State University, March 1974. (See annotation in Section VIII.)

Silvester, R. Sediment Transmission Across Entrances by Natural Means. Proceedings, XVIth Congress of the International Association for Hydraulic Research, Sao Paulo, Brazil, July 27 to August 1, 1975, vol 1, Paper A18.

When the water-particle orbits within a short-crested wave system are examined it must be concluded that the vortices and macro-turbulence generated should be conducive to sediment suspension. Tests carried out on model basins and observations in nature indicate the correctness of the theory in amplified velocities and mass-transport along paths of the combined crests. Beyond a structure the reflected waves create similar complex conditions, even when they are diffracted beyond the orthogonals through the limits of the wall. Harbor entrances can be designed to utilize the energy of the persistent swell to transmit sediment across them, which has occurred without full recognition. River mouths, being much wider generally, have not had training jetties designed on this basis, although some man-made and natural structures that were angled downcoast have been seen to be effective in this manner. This phenomenon needs much more research the results of which should prove extremely rewarding by reducing dredging costs. References (22 items).

Slotta, L.S., Sollitt, C.K., Bella, D.A., et al. Effects of Hopper Dredging and in Channel Spoiling (October 4, 1972) in Coos Bay, Oregon. Oregon State University, Corvallis, July 1973. 147p. (See annotation in Section V.)

Smith, B.N. The Role of Sea Grasses and Benthic Algae in the Geochemistry of Trace Metals in Texas Estuaries. Texas University, Department of Botany, October 1974.

A model was proposed and evaluated for trace metal accumulation in marine plants growing under changing environmental conditions. Monthly collections were made at 22 stations in estuaries near Corpus Christi. The results revealed significant fluctuations in the concentration of

Cd, Co, Cu, Mn, Ni, and Zn in sea water and in the accumulation of these trace metals in benthic plants. A mathematical relationship was determined between the accumulation of metals in benthic plants and the concentration of metals in sea water, a relationship remaining consistent for several metals and all plants tested. Finally, an interpretation of the above relationship revealed a better understanding of the significance of the Irving-Williams order of complex stability to the biochemistry of metals. Project Related Publications (3 items).

Snowden, J.O., and Otvos, E.G. Chemical Quality of Surface and Sediment Pore Water in Louisiana and Mississippi Estuaries. Louisiana Water Resources Research Institute, Completion Report B-009-LA, October 1973. (See annotation in Section VIII.)

Sollitt, C.K., and Crane, S.D. Physical Changes in Estuarine Sediments Accompanying Channel Dredging. Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, Copenhagen, Denmark, vol.II, 1975, Chapter 75 (p.1289-1303).

The physical characteristics of estuarine sediments provide useful information about sediment sources, the nature of bottom surface stresses and sediment transport mechanisms. Changes in sediment composition and state are also useful indicators for estimating the effects of unnatural stresses on dependent chemical and biological activities. In this study, the changes in several sediment properties have been monitored for an isolated estuarine dredging project. The effect of estuarine hopper dredge activities has been evaluated for an Army Corps of Engineers project at Coos Bay, Oregon. The project included suction head dredging at a shoal area within the navigation channel and in bay spoiling at a deep section of channel one mile downstream from the dredge site. Core samples were taken five days before dredging and two, thirteen and seventy days after dredging at the dredge and spoil sites. Subsequent laboratory analysis of the core samples revealed that dredging induced redistribution of bottom sediments produced significant changes in several physical characteristics of the dredged material. Repeated resuspension of bottom sediments during the dredging and spoiling operations caused a net loss of fine grained sediments and light organic constituents. Several symptomatic changes were observed which validate this finding, including: an increase in median grain size and decrease in uniformity of dredge spoils due to loss of fine fractions; a decrease in volatile solids in the dredge spoils due to a net loss of organics, a decrease in porosity at the spoils site due to the ability of the coarse grain sediments to resist resuspension; and a decrease in hygroscopic moisture content due to loss of porous organics and silt-clay material from the spoils. Conditions following dredging were observed for a period of seventy days. Partial recovery of the sediment system was observed after two weeks with no further recovery in two months. The initial recovery came about due to the availability of local sources of resuspended sediment adjacent to the dredge site. This occurred under low flow conditions in early fall. Complete recovery of the system was not observed and probably requires the relatively large sources of sediment which accompany heavy winter and spring runoff. Thus, the immediate effects of dredging may persist until the annual cycle of sediment erosion and deposition have occurred. Bibliography (4 items).

Specialty Conference on Dredging and its Environmental Effects; Proceedings; Mobile, Alabama, January 26-28, 1976. Edited by Peter A. Krenkel, John Harrison and J. Clement Burdick III. New York, American Society of Civil Engineers, 1976. (See annotation in Section V.)

Steele, J.G., Pearce, B.R., Wang, J.D., et al. Finite-Element Modeling of Moreton Bay, Australia. Ralph M. Parsons Laboratory for Water Resources and Hydrodynamics, Department of Civil Engineering, Massachusetts Institute of Technology, Technical Note No.20, July 1977. (See annotation in Section VI.)

Stride, A.H. Indications of Long Term, Tidal Control of Net Sand Loss or Gain by European Coasts. ESTUARINE AND COASTAL MARINE SCIENCE, vol 2, p.27-36, 1974.

Long sand banks elongated parallel with the main tidal flow are abundant in European seas and most have one slope steeper than the other. In the majority of these sand banks the direction faced by the steeper slope corresponds with the clockwise or anticlockwise sense of rotation of the tidal current vectors in relation to the net sand transport direction. This finding is interpreted as being the result of a lag effect in the picking up and putting down of the sand through the tidal cycle. It has considerable relevance to both the coastal engineer and the geologist as it suggests portions of coast which are likely to be

subject to a long term, net sand loss to, or gain from, the offshore zone. (References (17 items).)

Taylor, D. Natural Distribution of Trace Metals in Sediments from a Coastal Environment, Tor Bay, England. ESTUARINE AND COASTAL MARINE SCIENCE, vol.2, No.4, p.411-425, October 1974. (See annotation in Section VIII.)

Teleki, P.G., and Delaster, Z. Sediment Transport Studies for Port Engineering, Corinto, Nicaragua. Proceedings, XVIth Congress of the International Association for Hydraulic Research, Sao Paulo, Brazil, July 27 to August 1, 1975, vol.1, Paper A5.

A comprehensive set of sediment tracer experiments was carried out in 1973 at Corinto, Nicaragua, for the purpose of determining areal variations in the transport and budget of sediments at the entrance to the harbor, in the approach channel and at adjacent beaches from Peninsula Castanones to Isla Aserradores. The study served three objectives: to assist in the design of a deep-draft navigation channel, to determine areas of sedimentation for required dredging and to determine littoral processes along nearby beaches. The tracer experiments were supported by non-concurrent wave-, current- and tide data and offshore bedform mapping. Analysis of the hydrographic data indicates that the channel in Corinto Bay has been self-maintaining. The recent breakthrough at Paso Caballos did not result in appreciably reduced flushing at the harbor entrance but will affect the stability of the beach northwest of Corinto. Net sediment transport during the winter wave climate is to the northwest and sediment is stored in traps such as Sawyer's Bank and the bar seaward of Boca Falsa channel. Maintenance of the channel will be most frequent north of Caiman Island where sediments are carried across the channel. (References (6 items).)

Thompson, W.W., and Dalrymple, R.A. A History of Indian River Inlet, Delaware. SHORE AND BEACH, vol.44, No.2, p.24-31, July 1976.

Although the primary purpose of this paper was to recreate the interesting and unusual history of Indian River Inlet, a secondary but more important purpose was to emphasize the problems associated with the stabilization of a natural inlet. These problems are not unique to Indian River Inlet and should be considered in future projects. The interruption of the littoral drift which results in the simultaneous accretion and erosion of the beaches in the vicinity of the jetties is almost inherent with the construction of jetties. This problem not only requires the nourishing of the eroding beach but also frequent maintenance dredging of the channel. In view of the combined cost of both dredging and beach fill operations, a method of sand bypassing should be considered in future stabilization designs. Another common problem is the erosion of channel banks by wave action. This problem apparently necessitates the protection of the channel banks along their entire length. As evidenced by the many case histories of inlets, the design of jetties is not entirely satisfactory as many problems constantly re-occur. (References (7 items).)

Thorn, M.F.C. Deep Tidal Flow over a Fine Sand Bed. Proceedings, XVIth Congress of the International Association for Hydraulic Research, Sao Paulo, Brazil, July 27 to August 1, 1975, vol.1, Paper A27.

The integrated design and development of specialist equipment and computer analysis programs have permitted the field measurement of suspended solids - depth and velocity - depth profiles with a high degree of resolution in the important region near the bed. Sand flux data have thereby been obtained for deep tidal flow in estuaries where the predominant bed material is a fine sand with a median particle diameter less than 0.25 mm. The classical steady velocity-depth and suspended solids concentration-depth relationships adequately represent the measured profiles in unsteady deep tidal flow. Analysis of field data for complete tidal cycles reveals hysteresis in the relationship between water velocity and sand concentrations in suspension. Empirical curve-fitting techniques permit the analytical manipulation of the field data to predict changes in the transport of sand under changed conditions. These results have important implications in the modeling of estuary processes. (References (3 items).)

Thorn, M.F.C. Hysteresis of Fine Sand Suspensions in a Tidal Estuary. HRS NOTES (Hydraulics Research Station, Wallingford), No.17, p.1-4, June 1975.

Brief article on work done and development of equipment at the Hydraulics Research Station in Great Britain.

Thorn, M.F.C. Monitoring Silt Movement in Suspension in a Tidal Estuary. Proceedings, XVIth Congress of the International

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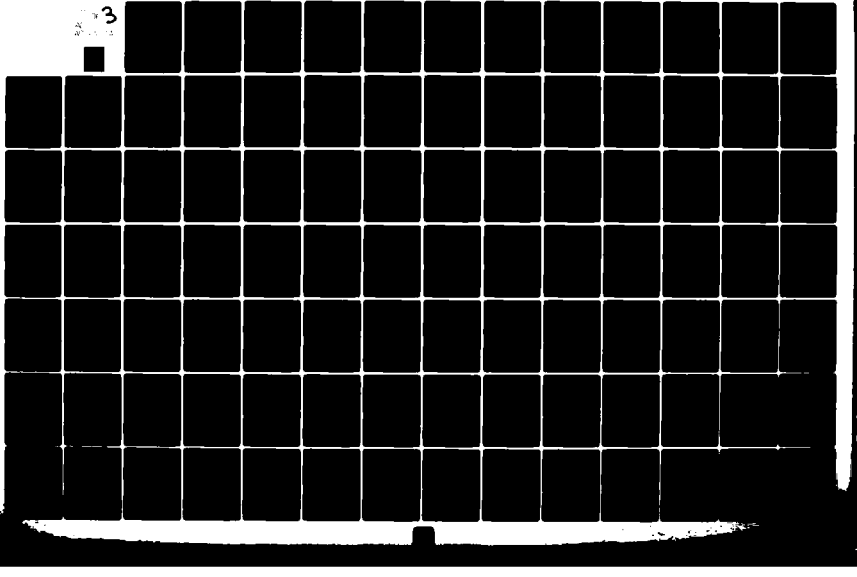

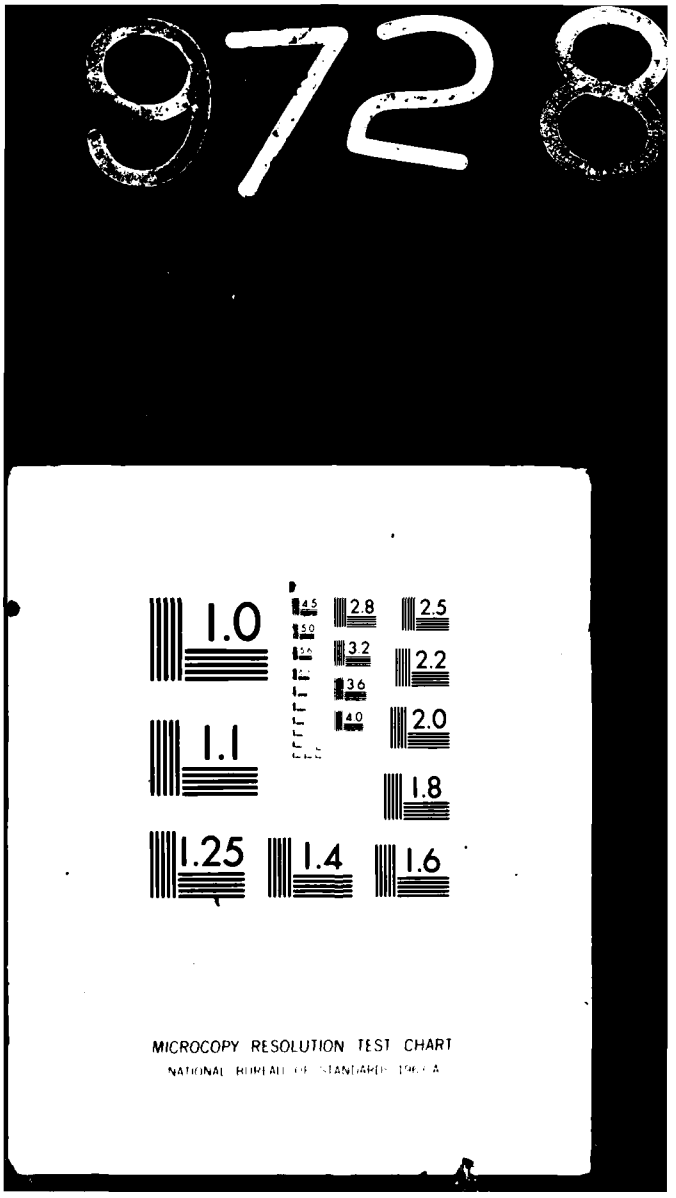
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Association for Hydraulic Research, São Paulo, Brazil, July 27 to August 1, 1975, vol.3, Paper C71.

Suspended solids concentrations in a tidal estuary exhibit significant tidal, diurnal and seasonal variations which can be evaluated only from a long-term program of continuous measurement. A monitoring system based on submersible optical sensors controlled by a magnetic tape data logger is being successfully operated at remote estuary sites. The data tape output is designed for cheap and rapid computer processing to give tabular, graphical and paper-tape presentations of suspended solids concentrations with respect to real time. A statistical reduction of the recorded concentration-time profiles provides the basis of correlation with other river parameters and a means by which changes in the pattern of tidal transportation of river solids are easily recognized. Analysis of data records shows that the shape of the normalized concentration-time profile is characteristic for a specific site, and may be interpreted in terms of the erosion or accretion of bed material by the theoretical construction of matching profiles. References (3 items).

Ulanowicz, R.E., and Flemer, D.A. A Synoptic View of a Coastal Plain Estuary. Hydrodynamics of Estuaries and Fjords; Proceedings of the 9th Liege Colloquium on Ocean Hydrodynamics, 1977, p.1-26. (See annotation in Section I.)

U.S. Army Engineer District, Philadelphia. Long Range Spoil Disposal Study. 7 parts in 8 vols., 1969-1973.

Part I: General Data for the Delaware River (furnishes the information and data on the Delaware River which is pertinent to the entire study). Part II: Sub-study 1, Short Range Solution (evaluates the remaining disposal area capacity in terms of its remaining life, and recommends any further desirable and acceptable disposal area developments). Part III: Sub-study 2, Nature, Source, and Cause of the Shoal; and Appendix A (develops in depth the basic data as to the nature of the Delaware River shoals, their sources, and their causes. It is hoped that this knowledge may reveal new concepts for the better control of shoals). Part IV: Sub-study 3, Development of New Dredging Equipment and Technique (identifies the best in dredging plant and dredging technique for Delaware River dredging maintenance tasks now and in the future). Part V: Sub-study 4, Pumping Through Long Lines (examines the merits of transporting dredged materials many miles through pipelines). Part VI: Sub-study 5, In-River Training Works (determines the potential of training works for control of shoaling. It involves considerable model testing). Part VII: Sub-study 6, Delaware River Anchorages (considers the effect of man-made anchorage on shoaling problems and the merits of alternate solutions).

U.S. Army Engineer District, San Francisco. Dredge Disposal Study, San Francisco Bay and Estuary. Main Report and Appendices A through M. 1974-1977. (See annotation in Section IV.)

U.S. Army Engineer Waterways Experiment Station. Chesapeake Bay Radioactive Tracer Study, by A.R. Tool. Miscellaneous Paper H-76-1, January 1976. (See annotation in Section VII.)

U.S. Army Engineer Waterways Experiment Station. Grays Harbor Estuary, Washington; Report 5, Maintenance Studies of 35-Ft-Deep (MSL) Navigation Channel; Hydraulic Model Investigation, by N.J. Brogdon, Jr. Technical Report H-72-2, Report 5, October 1975. (See annotation in Section VI.)

U.S. Army Engineer Waterways Experiment Station. Grays Harbor Estuary, Washington; Report 6, 45-Ft MSL (40-Ft MLLW) Navigation Channel Improvement Studies; Hydraulic Model Investigation, by N.J. Brogdon, Jr. Technical Report H-72-2, Report 6, April 1976. (See annotation in Section VI.)

U.S. Army Engineer Waterways Experiment Station. Improvements for Masonboro Inlet, North Carolina; Hydraulic Model Investigation, by W.C. Seabergh. Technical Report H-76-4, April 1976. 2 vols. (See annotation in Section VI.)

U.S. Army Engineer Waterways Experiment Station. Interim Report on Masonboro Inlet, North Carolina, Movable-Bed Model Tests, by N.W. Hollyfield. Miscellaneous Paper H-76-14, June 1976. (See annotation in Section VI.)

U.S. Army Engineer Waterways Experiment Station. Masonboro Inlet, North Carolina: Movable-Bed Hydraulic Model Study, Effects of Temperature and Experimental Procedures, by R.A. Sager and N.W. Hollyfield. Miscellaneous Paper H-75-10, December 1975. (See annotation in Section VI.)

U.S. Army Engineer Waterways Experiment Station. Mathematical Model of Estuarial Sediment Transport, by R. Ariathurai, R.C. MacArthur, and R.B. Krone. Technical Report D-77-12, October 1977. (See annotation in Section VI.)

U.S. Army Engineer Waterways Experiment Station. Model Studies of Navigation Improvements, Columbia River Estuary; Report 2, Entrance Studies; Section 4: Jetty A Rehabilitation, Jetty B, and Outer Bar Channel Relocation, by F.A. Herrmann, Jr. Technical Report No.2-735, Report 2, Section 4, July 1974. (See annotation in Section VI.)

U.S. Army Engineer Waterways Experiment Station. Tillamook Bay Entrance Refraction Study, Tillamook, Oregon, by L.Z. Hales. Miscellaneous Paper H-77-8, August 1977. (See annotation in Section I.)

U.S. Army Engineer Waterways Experiment Station. Tillamook Bay Model Study; Hydraulic Model Investigation, by G.M. Fisackerly. Technical Report H-74-11, November 1974. (See annotation in Section VI.)

Vallianos, L. A Recent History of Masonboro Inlet, North Carolina. In: Estuarine Research, Volume II: Geology and Engineering, edited by L. Eugene Cronin, Academic Press, Inc., New York, 1975, p.151-166. (See annotation in Section V.)

Visher, G.S., and Howard, J.D. Dynamic Relationship Between Hydraulics and Sedimentation in the Altamaha Estuary. JOURNAL OF SEDIMENTARY PETROLOGY, vol.44, No.2, p.502-521, June 1974.

Flood and tidal cycles in the Altamaha Estuary produce differing bedforms, sedimentary structures, thickness of sedimentary units, and grain size distributions. Differences are the result of changes in bed shear, flow regime, and mechanisms of sediment transport. The salt wedge developed on flood cycles produces a stratified estuary with highest flow velocity below the highest rate of salinity change. This relation results in upper flow regime as predicted by the densimetric Froude relation; trochoidal in phase waves to 2 m in height are formed. Surface waves and internal waves are seen in the salinity stratification. Ebb flow modifies the sand wave surface, and sediment transport is by ripples and dunes in the lower flow regime. Large-scale planar cross-bedding is produced by flood flow; small-scale ripple and dune structures are developed by ebb flow. The estuary is an effective mechanism for size segregation. Suspension populations are removed by both flood and ebb flow. There is a net inland transport of suspended sediment with deposition on tidal flats and marshes. A single log-normal source population is fractionated into several differing populations by bedload transport, suspension and recycling during successive tidal cycles. Characteristic log-probability size distributions are developed in different environments. References (19 items).

Vittor, B.A. Effects of Channel Dredging on Biota of a Shallow Alabama Estuary. JOURNAL OF MARINE SCIENCE, vol.2, No.3, p.111-133, 1974. (See annotation in Section V.)

Wakeman, T. Conditions of Pollutants During Dredging and Disposal Operations in San Francisco Bay. Proceedings of a Workshop on Algae Nutrient Relationships in the San Francisco Bay and Delta, held November 8-10, 1973, at Clear Lake, California, p.195-202. The San Francisco Bay and Estuarine Association, 1975. (See annotation in Section IV.)

Walther, A.W. Research in the Haringvliet Estuary. Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, Copenhagen, Denmark, vol.III, 1975, Chapter 146 (p.2483-2494).

After the closure of the Haringvliet estuary, part of the Netherlands Delta Project, morphological changes have occurred. Until now it was impossible to give a completely satisfactory forecast of such changes, however, with the aid of the Leendertse tidal computations a good picture of the tidal flow in the estuary can be obtained. In the paper a short description is given of both the tidal flow and the morphology of the Haringvliet estuary related with some problems of the practicing engineers. References (2 items).

Walton, T.L., and Dean, R.G. Use of Outer Bars of Inlets as Sources of Beach Nourishment Material. SHORE AND BEACH, vol.44, No.2, p.13-19, July 1976.

Outer bars of inlets appear to contain large quantities of high quality material which can be used for beach nourishment purposes without significant adverse effects on adjacent beaches. This is

particularly the case in areas of low average wave energy in which the size of the outer shoal is not limited by shoreward-directed sediment transport forces due to waves. The sheltering and refraction due to the resulting large outer shoals can cause non-uniform distribution of alongshore sediment transport along the adjacent barrier islands, resulting in associated areas of severe erosion and possibly the eventual breakthrough and formation of new inlets. Although the effective utilization of outer bar material will require innovative approaches to dredging technology, the split-hull work barge concept appears promising, particularly if a self-loading capability can be added. The effect of removal of outer shoal material on adjacent beaches must be assessed for each individual situation and the relative merits of possible preferable material characteristics from these source areas weighed against increased pumping costs, etc. To properly assess the benefits to beach stability of different sized material from competing borrow areas, it will be necessary to evaluate existing methods of assessing compatibility of beach fill or develop improved procedures. References (11 items).

Wang, Y.-H., Smutz, M., Ruth, B.E., et al. Satellite Applications to a Coastal Inlet Study, Clearwater Beach, Florida. University of Florida, Gainesville, Coastal and Oceanographic Engineering Laboratory, UFL/COEL-77/026, December 1977. (See annotation in Section VII.)

Warme, J.E., Sanchez-Barreda, L.A., and Biddle, K.T. Sedimentary Patterns and Processes in West Coast Lagoons. Estuarine Processes; Volume II, Circulation, Sediments, and Transfer of Material in the Estuary, edited by Martin Wiley. New York, Academic Press, 1977, p.167-181.

We have studied two tidal lagoons, Mugu Lagoon in temperate California and Laguna Potosi in tropical Mexico. Critical for the sedimentology, ecology, and history of the lagoons is their inlet position and condition (open or close). Sedimentation is tidally controlled when the inlets are open and negligible when they are closed. Sand distribution is controlled by present and past inlet positions, and in both lagoons sand is the dominant sediment and the foundation material. Open inlets allow tidal currents to move sand from the beach into channels and tidal flats proximal to the inlet and promote transport of mud into distal reaches. Lagoon waters are then marine and support abundant life. When the inlets are closed, lagoon waters are quiet and sediment input is neglibible except for washover and eolian sand from beaches and dust from adjoining land. Lagoon waters may become stagnant and/or hyposaline. Significant for sedimentation and evolution of the lagoons are differences in climate, stream runoff, orientation with the inlet, and vegetation. Mugu Lagoon is irregularly estuarine, is elongated perpendicular to its inlet, thus minimizing fresh water flushing, and is dominated by an upper tidal zone salt marsh and thus has extensive intertidal flats. In contrast, Laguna Potosi is annually estuarine, is elongated between its inlet and a fresh water effluent, thus being completely flushed, and has vegetation dominated by lower tidal zone mangroves that have fixed its perimeter. Presently the lagoon inlets are artificially kept open to assure normal marine circulation, thus circumventing the temporal vagaries of the natural inlet cycle, hastening sand deposition and shortening the life of the lagoons. References (12 items).

Weston, A.E. The Measurement of Interactive Freshwater and Tidal Flows in the River Dee, North Wales. JOURNAL OF THE INSTITUTION OF WATER ENGINEERS AND SCIENTISTS, vol.33, No.1, p.69-79, January 1979. (See annotation in Section I.)

Wetzel, R.L. Carbon Resources of a Benthic Salt Marsh Invertebrate "Nassarius Obsoletus" Say (Mollusca: Nassaridae). Estuarine Processes; Volume II, Circulation, Sediments, and Transfer of Material in the Estuary, edited by Martin Wiley. New York, Academic Press, 1977, p.293-308.

The mud snail, Nassarius obsoletus Say, occupies the intertidal mud flat area of the salt marsh ecosystem at Sapelo Island, Georgia, and is classed as a detritovore. The three principal carbon resources available for ingestion by the intertidal population are Spartina alterniflora Loisel derived carbon (plant detritus), microbial carbon (bacteria), and benthic algae (primarily pennate diatoms). Uptake studies using ^{14}C labeled substrates indicated that the structural carbohydrate fraction (crude fibre) of the plant detritus was not assimilable. Uptake and retention of ^{14}C by N. obsoletus occurred only on microbial and algal labeled substrates. Extrapolating the calculated short term uptake and retention rates to a daily basis for these two carbon resources, total incorporation would balance a daily body carbon loss of 5 to 6%. There was evidence from the

uptake studies that N. obsoletus functions more as a "grazer" on the mud flat area than a strict detritovore. Label uptake was approximately 2.3 times greater on the algal substrate than the microbial and ingestion significantly reduced algal standing crop in the experimental cores. Net carbon retention efficiency for both substrates was 46%. Literature Cited (30 items).

Whalin, R.W. Hydraulic Model Evaluation of Coastal Evolution Due to Offshore Structures. SHORE AND BEACH, vol.43, No.1, p.9-20, April 1975. (See annotation in Section VI.)

Windom, H.L. Unconfined Dumping of Dredge Spoil Said Better Than Dike Method. THE WORK BOAT, vol.29, No.10, p.36, 38, 40, 42, October 1972.

The environmental effects of dredging in coastal waters characterized by salt marsh estuaries are discussed in terms of alteration of habitats due to deposition of dredged material and water quality impairment of the surrounding waters. Experimental evidence indicates marsh areas will return rapidly to their original chemical characteristics, if proper consideration is given to the depth of spoil deposit. In unpolluted areas where undiked spoil deposition techniques are used, no significant water quality impairment appears to take place in the general area of dredging activity. Dredge spoil deposition using diked confinement techniques, contrary to experience in freshwater environments, is potentially more environmentally dangerous than undiked techniques. Water quality impairment is linked to the use of diked techniques and eutrophication may occur in such confined areas.

Windom, H.L. Water-Quality Aspects of Dredging and Dredge-Spoil Disposal in Estuarine Environments. In: Estuarine Research, Volume II: Geology and Engineering, edited by L. Eugene Cronin, Academic Press, Inc., New York, 1975, p.559-571. (See annotation in Section IV.)

Windom, H.L., Neal, W.J., and Beck, K.C. Mineralogy of Sediments in Three Georgia Estuaries. JOURNAL OF SEDIMENTARY PETROLOGY, vol.41, No.2, p.497-504, June 1971.

Mineralogical analyses of suspended sediments and bottom sediments from three Georgia estuaries (Altamaha, Ogeechee, and Satilla Rivers) indicate that the clastics of this area are a mixture of fluvially derived Piedmont and Coastal Plain detritus, and fines derived from the continental shelf. High illite-montmorillonite clay suites are transported into the estuaries from offshore during flood tide, whereas kaolinite plus minor mixed-layer clay, vermiculite and talc from the Piedmont and montmorillonite from the Coastal Plain and/or paralic sediments characterize the upstream and intermediate areas of mixing within the estuaries. Decreasing flow velocity and flocculation of the clays, probably induced by salinity changes, results in a general change in bottom sediments from sand in the rivers to clay in the estuaries. Sands and silt fractions are high in quartz with significant amounts of feldspar in the Altamaha (Piedmont source). Heavy-mineral composition of these sediments reflects the proportionality of the division of the drainage basins between the Piedmont and the Coastal Plain. The former is characterized by unstable suites, whereas the latter contributes stable to ultrastable assemblages. Sorting is generally poor reflecting a variety of processes which influence the sediments within the estuary. The work amplifies the conclusions of previous workers that shoreward transport, especially for the fine fraction, is an important process in determining the composition of the estuarine sediments. References (12 items).

Wing, R.H., Editor. A Test Particle Dispersion Study in Massachusetts Bay. U.S. National Oceanic and Atmospheric Administration, NOAA Technical Report ERL 374-MESA 6, September 1976. (See annotation in Section VII.)

Wollast, R. Modelling of Biological and Chemical Processes in the Scheldt Estuary. Hydrodynamics of Estuaries and Fjords; Proceedings of the 9th Liege Colloquium on Ocean Hydrodynamics, 1977, p.63-77. (See annotation in Section VI.)

Wright, L.D., and Sonu, C.J. Processes of Sediment Transport and Tidal Delta Development in a Stratified Tidal Inlet. In: Estuarine Research, Volume II: Geology and Engineering, edited by L. Eugene Cronin, Academic Press, Inc., New York, 1975, p.63-76.

Paper presented at the Second International Estuarine Research Conference, held by the U.S. Estuarine Research Federation at Myrtle Beach, South Carolina, 15-17 October 1973. Flood-tidal and ebb-tidal deltas in East pass, on the northwestern coast of Florida, contrast

sharply in form and absolute size. The flood-tidal delta, the more extensive, is characterized by a broad middle-ground shoal separating two diverging flood channels, whereas the ebb-tidal delta consists of a single seaward-narrowing channel flanked by subaqueous levees and having a symmetrical, crescentic, subaqueous bar at the outlet. Form differences result partially from variations in the intensities of different effluent expansion and deceleration mechanisms arising from vertical density stratification. Over the flood-tidal delta, bayward flood flow is concentrated near the bottom beneath lighter bay water. This inflow expands as a hyperpycnal effluent under the influence of bottom friction to produce the observed configuration of the flood-tidal delta. Because flood currents attain their velocity and duration maxima in the lower layer near the bottom, bed-load transport in the channels of the flood-tidal delta is flood-dominated. During ebb, outflow over the ebb-tidal delta is initially buoyant and is restricted to the upper layer as dense sea water intrudes into the inlet near the bottom. With increasing ebb velocities, the salt wedge is forced seaward to a stationary position over the bar front, and outflow in the region between the outlet and the bar crest becomes turbulent. This sequence is similar to that which characterizes the stratified mouths of the Mississippi between low and high river stages. The morphology of the ebb-tidal delta appears to be roughly analogous to that exhibited by stratified river mouths. References (17 items).

Wright, L.D., Coleman, J.M., and Thom, B.G. Sediment Transport and Deposition in a Macrotidal River Channel: Ord River, Western Australia. In: Estuarine Research, Volume II: Geology and Engineering, edited by L. Eugene Cronin, Academic Press, Inc., New York, 1975, p.309-321.

The funnel-shaped channel of the lower Ord River in Western Australia experiences a semidiurnal spring-tide range of 5.9 meters. The tidal prism substantially exceeds river discharge throughout the lower 65 km of the channel, and most of the sediments contributed to the system by the river are transported and deposited by tidal currents. The tide wave is symmetrical at the mouth but becomes deformed upstream owing to a high amplitude/depth ratio. Accordingly, the velocity of flood currents increasingly exceeds ebb velocities upstream, whereas ebb flow increases in duration. In and seaward of the mouth, bed-load transports by flood- and ebb-tide currents are approximately equal. Linear subaqueous sand ridges parallel to tidal currents separate mutually evasive zones of flood- and ebb-dominated sediment transport and appear to be related to convergence of flood- and ebb-oriented bedforms. In response to the upstream increase in tide-wave asymmetry, the largest bedforms within the channel migrate upstream under the influence of flood currents. The upstream increase in asymmetry of the channel cross section and in channel sinuosity. This results in concentrating ebb flows in the decreased cross section of channels, where bed-load transport is ebb-dominated, thereby balancing the sediment budget. References (7 items).

Yalin, M.S., and Karahan, E. Steepness of Sedimentary Dunes. Journal of the Hydraulics Division, Proceedings, ASCE, vol.105, No.HY4, p.381-392, April 1979.

A family of curves is determined for the prediction of the steepness of dunes generated by rivers and open channel flows by using field and laboratory data from various sources. The dune steepness appears to be determined by two dimensionless variables: the ratio of the existing bed shear stress to the shear stress inducing the inception of sediment transport, and the ratio of the flow depth to the grain size of sediment. It has been found that with the increment of the former variable the dune steepness first increases, then reaches its maximum value and then progressively decreases as to vanish asymptotically. The increment of the second variable causes only the increment of the dune steepness up to a certain upper limit. References (15 items).

Yalin, M.S., and Price, W.A. Formation of Dunes by Tidal Flows. Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, Copenhagen, Denmark, vol.II, 1975, Chapter 57 (p.991-1008).

Schematical relations for the size of dunes and for the duration of their development are derived assuming that the large scale formations on the surface of a movable bed are due to the largest eddies of turbulence. The considerations are confined to the simplest case of a two-dimensional flow and to the cohesionless granular material. The relations for tidal dunes are obtained by generalizing the relations for unidirectional flow dunes. Special cases and the validity regions of the forms presented are discussed; suggestions for future measurements and model tests are included. References (7 items).

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SECTION III. SALINITY EFFECTS

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Construction of the west end of the Cross Florida Barge Canal changed the regimen of the lower Withlacoochee River. The investigation was made to determine how salt water from the Gulf of Mexico moves in the river-canal complex, and how the factors that control salt-water movement--tides and discharge--have changed since canal construction. In the river below the bypass channel, salt water moves inland as a wedge beneath the fresh water with upstream tidal flows and back toward the Gulf with downstream tidal flows. The salt front in the river tends to move farthest upstream near times of relatively high higher high water, higher high water preceded by relatively high higher low water, especially during or after several days of rising mean tide level. References (5 items).

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A set of model equations describing the time-averaged velocity and salinity in an estuary is discussed and used to obtain expressions for the longitudinal and vertical components of velocity and for the salinity distribution. The theory is shown to be self-consistent in the central part of the estuary and to be in reasonable agreement with observations reported by Harleman & Ippen (1967). Finally it is argued that theoretical treatments of this problem which use a steady one-dimensional diffusion equation to describe the longitudinal salinity distribution are physically unrealistic. References (17 items).

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The waters between Vancouver Island and the mainland coasts of British Columbia and the State of Washington constitute a complex estuarine system in which the dominant source of fresh water is the Fraser River. Before any realistic ecological models relating to the major fisheries of the region, including possible effects of domestic and commercial effluents or of oil spills, can be undertaken it is necessary to achieve a quantitative understanding of the physical processes that determine the essential character of the flow field and distributions of scalar properties. This involves an extended series of studies and it is the purpose of the paper to review briefly the present status of this work with emphasis on the roles played by the tides and tidal streams, then to describe, and present some results from, a numerical tidal model and lastly to indicate in general terms how these results are presently being used to introduce the effects of tides into an experimental "upper layer" model used to study the flow of fresh water from the Fraser River over the salt water in the Strait of Georgia. References (40 items).

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A general numerical model capable of reproducing long internal waves in stratified fluids has been constructed with the aim of investigating the salt wedge penetration in the Delta of the Po river, where the installation of a 2640 MW thermo-electric plant is foreseen. The working hypothesis of the model, in accordance with the actual phenomenology of the river, is the one-dimensional

homogeneous motion of two fluid layers of different density. The main original aspects of the numerical computation are: 1) The use of two different space steps (1 km for the fresh water layer; 200 m for salt water) simultaneously allowing a good description of internal waves (the velocity of which is much smaller than that of the external ones) and making it possible to work with economic (100 sec) time steps. 2) The straightforward description of the wedge head, obtained by making it always freely correspond to one of the grid points. The model, which has been tested on actual events, reproduces reality with a very good approximation; it also gives evidence of the small relevance of the interfacial stress coefficient in unsteady tidal generated motion of the salt wedge. References (18 items).

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A two-layer monodimensional numerical model constructed in order to investigate the penetration of sea water in the Delta of the river Po proved adequate to well describe the salt penetration in form of a fully stratified wedge. On the other hand the mixing processes of the head cannot be taken into account in such a schematization. Two possibilities of modeling the stratified motion of the head are available: the parameterization of the upper layer salt intrusion (by entrainment hypothesis) or the use of a two-dimensional desription of the flow in the vertical plane. The use of the concept of entrainment coupled with the Richardson number as stability criterion for the stratified motion makes it possible to introduce mixing into the monodimensional two-layer scheme. The correspondence of this scheme with the actual physical structure of the salt wedge is at the present being tested by a specific field measurement program. References (8 items).

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Various methods for the estimation of the interfacial shear stress coefficient have been examined to determine the significant parameters and the best method for computing the coefficient for practical purposes. An interim procedure is suggested which gives consistent results over a wide range of Reynolds numbers and different wedge types. Some additional field data is given in support of the computation method employed. References (17 items).

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There are several methods by which the dispersion of salt in estuaries is analyzed using cross-sectional as well as time averaging. These are compared using data from three estuaries. The results show that in a highly stratified estuary the lateral contribution to the dispersion is small. In two partially mixed estuaries the lateral contribution is of the same order of magnitude as the vertical. References (13 items).

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Elliott, A.J. A Steady State Two-Layered Non-coupled Dynamic and Kinematic Estuarine Model with Application to the Potomac Estuary. Chesapeake Bay Institute, The Johns Hopkins University, Special Report 44, Reference 75-6, July 1975. (See annotation in Section VI.)

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Various mechanisms for intrusion of salinity into estuaries are discussed, and previous analyses are used to determine the relative importance of each in San Francisco Bay. According to the Hansen and Rattray stratification-circulation diagram approximately 70% of the upstream flux of salt should be by processes other than gravitational circulation. This result is supported by other analyses and by the findings of a set of hydraulic model studies; in the model studies salinity intrusion with normal salinity in the ocean was compared to salinity intrusion when the gravitational circulation was essentially eliminated by reducing the salinity in the ocean. The intrusion distance of dimensionless salinity was essentially the same in the two runs. It is concluded that salinity intrusion in San Francisco Bay is caused mostly by the effect of shoreline irregularities, rather than by gravitational circulation. References (12 items).

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Experiments carried out at anchor stations in the Duwamish River in Seattle, Washington, showed a period of intense

vertical salt flux during the ebb tide. In order to examine the longitudinal structure of these mixing events, as well as to procure data relevant to the overall dynamics of the estuary, a system was developed to permit measurement of the velocity and density fields from a moving vessel. The new system was used in an experiment in March 1977. Data obtained during this experiment indicate that the intense mixing events may be triggered by a hydraulic jump that occurs at a sharp change in river depth. The relatively high salinity water formed at the jump advects downstream, but vertical mixing continues with a salt flux of at least 0.5 $gm/m^2 \cdot sec$. It is postulated that this continued mixing is related to an internal hydraulic instability. As it occurs during periods of minimum shear, shear instability is ruled out as a source of energy. In addition to the intense mixing events, an internal hydraulic jump that forms at the 16th Avenue bridge around the time of maximum ebb is described. While this apparently is not related to the intense mixing events, it is of interest in its own right, and indicates the importance of internal hydraulics to the dynamics of salt wedge estuaries. References (8 items).

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Analysis of salinity data from the lower York and Rappahannock Rivers (Virginia, U.S.A.) for 1974 revealed that both of these estuaries oscillated between conditions of considerable vertical salinity stratification and homogeneity on a cycle that was closely correlated with the spring-neap tidal cycle, i.e. homogeneity was most highly developed about 4 days after sufficiently high spring tides while stratification was most highly developed during the intervening period. The stratification-mixing cycle was generally more closely correlated with the height of high tide than with the magnitude of the tidal range. As a result of the annual cycle in the magnitude of spring high tides, periods of homogeneity were both more numerous and more intense in the late summer than in the winter. Variation in river flow appeared to be of secondary importance in regulating the hydrography of this estuary. Analysis of salinity data collected during the period following Tropical Storm Agnes (July-August 1972) revealed that cycles of stratification and mixing occurred simultaneously throughout the entire salt influenced lengths of the James, York and Rappahannock Rivers. These cycles were similar to those described above and appeared to be a manifestation of the normal oscillatory nature of the estuaries and not a result of storm related flood waters. References (17 items).

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The peak effect of the flood waters produced by Tropical Storm Agnes was seen on June 25 in the James, June 26 in the Rappahannock, and June 30 in the York. Recovery toward normal salinity conditions after the high runoffs proceeded discontinuously, with alternating periods of vertical stratification and destratification. During strongly stratified stages, saline water advanced upstream along the bottom. In the York and James Rivers, the most dramatic stratification occurred about July 20-25. This event resulted in bottom salinity values exceeding normal ambient values and, at the river mouths, reaching values hitherto unobserved. This event was apparently controlled by the salinity distribution in the Bay. Less pronounced stratification maxima occurred in the James about July 6 and August 18 and in the York during August. These events do not appear

to be correlated with stream gauge flow records or local precipitation. These events are possible instances of overshooting of equilibrium by the intruding salt water near the bottom. Literature Cited (1 item).

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Prepared by U.S. Geological Survey, Water Resources Division, in cooperation with South Carolina Water Resources Commission, Columbia, South Carolina, 1976. A reconnaissance study has been made to provide background information on some of the physical and chemical characteristics of the Edisto and Ashepoo estuaries in South Carolina. Data were collected from the estuaries on the physical dimensions, tidal stages, saltwater intrusion at high and low tides, and water quality above the saltwater intrusion. During average freshwater inflow conditions, the interface between freshwater and saltwater penetrates the Edisto estuary to mile 19.5 and the Ashepoo estuary to mile 24 at high tide. Above the saltwater interface, the water of both estuaries is of good quality and suitable for most uses if treated for iron and color. The bed sediments throughout the study area, with the exception of iron, have little or no indications of heavy metals, herbicides or pesticides and, as such, probably are an indication of good water quality. Selected References (16 items).

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Kuo, A.Y., Ruzecki, E.P., and Fang, C.S. The Effects of the Agnes Flood on the Salinity Structure of the Lower Chesapeake Bay and Contiguous Waters. In The Chesapeake Research Consortium, Inc., The Effects of Tropical Storm Agnes on the Chesapeake Bay Estuarine System, CRC Publication No.54, November 1976, p.81-103.

The transient response of salinity distribution in lower Chesapeake Bay to flood waters from Tropical Storm Agnes is studied in terms of a two-layered, partially mixed estuary. Prior to 30 June 1972, surface salinities were well depressed throughout the Bay while those at the bottom near the Bay mouth were not depressed by 5 July. This resulted in a highly stratified situation normally found in the spring of the year. Stratification decreased when bottom waters were flushed down-bay by the flood (on 5 to 10 July for the region south of New Point Comfort). The "rebound" of salinity structure started immediately after the passage of the flood water which otherwise retarded up-bay movement of bottom waters. This "rebound" began on 13 July near the Bay mouth and progressed up-bay reaching the mouth of the Potomac River by 20 July. During this period, surface salinity remained low, resulting in strong stratification again. The recovery of surface salinity by tidal mixing finally weakened stratification to a near "normal" salinity structure by the end of August. The large mass of flood water leaving the Bay mouth is treated as a natural tracer release. The distribution of flood water on the continental shelf indicates that pulses of freshened surface water left the Bay on ebb tide and were separated from one another by intrusion of saltier shelf water on flood tide. During the period when the wind speed was below 4 m/s, the flood water remained in the upper 10 meters of the water column and traveled southward with a speed of 80 cm/sec. Literature Cited (6 items).

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Observations of velocity and salinity profiles over a tidal cycle were made throughout the Guayas estuarine complex. Bihourly maps of the tidal current field show a nearly 2-hour phase shift from the estuary mouth to Guayaquil and a slack-water/high-tide phase lag in accordance with a frictionally retarded long wave in a nonuniform channel. A zone of intense mixing of river water and sea water is identified south of Guayaquil, and the flushing time indicated by the longitudinal salinity distribution is calculated at about 21 days. Gravitational convection is poorly developed and present only locally, but a significant upstream salt flux does occur in the tidal prism. The Hansen and Rattray circulation-stratification diagram successfully classifies the Guayas system as a poorly developed, partially mixed (type 2B) estuary. References (13 items).

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Detailed measurements over a tidal cycle of salinity and current speed were taken across a section of the high-tidal-range (3.0 m), shallow (6.5 m) estuary of the Rio Guayas in Ecuador. Despite a low freshwater discharge and intense mixing by the strong (1-1.5 m/sec) tidal currents, an ideal well mixed estuary does not develop; a weak vertical salinity gradient persists along the channel. A decomposition of the time-averaged salt flux $Q_S = \int\int u\ s\ d\ A$ into 18 terms accounting for the mean advective salt flux, changing cross-sectional area, vertical and lateral gradients in speed and salinity, and time deviations from the time means show that 87% of the total downstream salt flux is accounted for by the freshwater discharge but that 61% of the upstream salt flux necessary to maintain the salt balance is produced by upstream turbulent diffusive flux. This high value for the diffusive flux is predicted by the theories of Hansen and Rattray. Gravitational convection and lateral shear effects make unimportant contributions to the salt balance. Further computations are made of the temporal and spatial variations of the eddy stresses in the channel. The role of the time-dependent nature of the cross-sectional area on the structure of the eddy stresses is isolated for the first time. References (6 items).

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The determination of sea-water intrusion length in stratified estuaries is very important for the solution of some estuary problems. Existing relationships for the matter do not give satisfactory results. The factors which govern the sea-water intrusion length, the estuary parameters, are evaluated and principles to estimate the length correction factor from the limited field data are demonstrated. The two new factors, estuary shape factor and Reynolds number for the river, are taken into consideration. Observations show that the general formulization of sea-water intrusion length depends on the introduction of these two factors into the related relationships. Reference.

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Results of previous analytical and experimental studies on the mechanism of arrested saline wedges have been critically reviewed, compared and reanalyzed. This review and reanalysis led to an

improvement and refinement of earlier equations, formulas and procedures for the evaluation of the length, shape and shear stresses at the interface and at the bed of an arrested saline wedge. A number of related significant parameters are presented in graphical form for the expedience of engineering computations. References (5 items).

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Pedersen, F.B. A Brief Review of Present Theories of Fjord Dynamics. Hydrodynamics of Estuaries and Fjords; Proceedings of the 9th Liege Colloquium on Ocean Hydrodynamics, 1977, p.407-422. (See annotation in Section I.)

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Symposium sponsored by the International Association for Hydraulic Research and the Academy of Sciences of the U.S.S.R. In Part 1 of this paper the basic concepts and equations of stratified, miscible flow are introduced. In Part 2 the mechanism of entrainment is explained physically, i.e., how it occurs and why it is a oneway transport process from the nonturbulent to the turbulent layer. With the use of the momentum and work energy equations, both with due respect to the net entrainment, the dimensionless entrainment is found to be equal to the friction coefficient. In Part 3 the differential equations are found for the depth and density variations of a layer of brackish water flowing over a pool of salt water. The general equations are based on a two-dimensional model, but in Part 3 the solutions of the differential equations are shown for a gradually varying width. In Part 4 a numerical example for a Norwegian fiord is shown. References (3 items).

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Variations in Sacramento-San Joaquin River discharge into northern San Francisco Bay cause shifts in location of the bottom density current null zone. At a river flow of 2000 m^3/s this null zone is approximately 20 km from the seaward end of the estuary, whereas at a river flow of 100 m^3/s it is 80 km from the seaward end; the corresponding distances of salinity penetration are approximately 40 and 90 km from the seaward end. Seaward of the null zone, during low (summer) river discharge conditions, the inward-flowing bottom density current appears typically strong (5-15 cm/s) relative to the outward-flowing river current (river discharge per unit cross-channel area) of < 2cm/s. Landward from this null zone the average river current increases with decreasing cross-channel area. This circulation implies that during the summer water within the null zone has the longest average advective replacement time relative to water seaward or landward of the null zone. References (42 items).

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It is important to explore new methods of predicting fresh water flow into the estuary because usual methods of stream gauging are found inapplicable for tidal rivers. Making use of the salinity data with respect to a particular section along the estuary for two years, 1965 and 1966, tidal range, and the estimated fresh water discharge into the estuary, regression analyses have been attempted and regression equations are being derived on the basis of available data. This fresh water discharge is comprised of runoff from the catchment, sewage and effluents from industries and precipitation over the estuary. The data pertaining to 33 ebb tides and 20 flood tides are used for these analyses. Encouraging results are obtained based on the regression analyses of various estuarine parameters. Reference (1 item).

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Theoretical results are obtained for salt-wedge estuaries which give the velocity profile, stress distribution, shape and length of the wedge for steady-state flow conditions. It is assumed that the cross-section is rectangular. Cases are presented for both constant depth and uniformly sloping bottom. The dynamics resemble those found in open channel flow with the addition of a laminar boundary layer at the interface between the wedge and the upper layer. The theory gives reasonable predictions for the length and shape of salt wedges observed in flumes and in the Mississippi and Duwamish Rivers. References (25 items).

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The West Lakes land reclamation scheme in metropolitan Adelaide will include a 200 acre lake containing seawater and flushed by tidal action. Thirteen square miles will drain into the lake. Stormwater flow into the West Lakes area was predicted by the Road Research Laboratory method and measured by automatic stream gauges. Tidal flushing was simulated on a computer and the effect of stormwater superimposed on the flushing studies. The tidal flushing was also the subject of hydraulic model studies. Reference (1 item).

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Contents: Introduction, K.P. Blumenthal. Density Currents Due to Differences in Salinity, G. Abraham. Empirical Methods of Forecasting Movement of Salt in Estuaries, F. Langeweg and J.J. van Weerden. Mathematical Investigation of Stratified Flow, C.B. Vreugdenhil. The Use of Hydraulic Models for the Study of Salt-Fresh Water Currents in Aid of Measures to Prevent Salt Water Penetration, P.A. Kolkman. Synthesis and Its Application

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Sanmuganathan, K., and Abernethy, C.L. A Mathematical Model to Predict Long Term Salinity Intrusion in Estuaries. Reprint from Proceedings Second World Congress, International Water Resources Association, New Delhi, vol.III, p.313-324, December 1975.

This work describes a mathematical model that was developed to predict salinity intrusion in estuaries as it is affected by control and abstraction of fresh water. The need for such a model, particularly for estuaries in tropical areas with large variations in fresh water flow, capable of giving satisfactory predictions of salinity movement from limited field data, is outlined. The difficulties in using existing mathematical models are also brought out. The model outlined in this paper overcomes these difficulties by developing an approximate analytical solution of the unsteady high-water slack mass balance equation. The model relies on estimating the value of the longitudinal dispersion coefficient from field data obtained within a period less than six months. The predictions made for a continuous period of over two years are shown to agree well with observations. The predictions made by the model for salinity movement under different fresh water abstraction and regulation patterns are presented. References (11 items).

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The passage of Tropical Storm Agnes through the drainage basin of the Chesapeake Bay in June 1972 resulted in record, or near-record, flooding of most of the major tributaries. The tidal reaches of the Susquehanna River were extended nearly to the Bay Bridge at Annapolis, nearly 35 km farther seaward than previously reported. The high discharges sent salinities in most of the Chesapeake Bay estuarine system to levels lower than any previously reported. Minimum salinities in the surface layer of the Maryland portion of the Bay were reached within a few days of peak riverflow, and the zone of surface salinities less than 1 ppt extended seaward to the mouth of the Little Choptank. Minimum salinities in the bottom waters of the upper Bay were not reached in some areas until the middle of July, and minimum salinities were not observed in the mouth of the Bay until about a month after peak flooding. Surface salinities remained depressed throughout the summer, while bottom salinities increased to "normal" levels over this same time interval by the upstream movement of salty water in the lower layer. The large freshwater inputs and the compensatory upstream flow of salty water in the lower layer produced large vertical salinity gradients. Even in early fall vertical gradients were typical of spring conditions. The outflow of water from the Bay could be traced as a band of low salinity water leaving the Bay, turning south, and moving along the Virginia and North Carolina coasts. Literature Cited (6 items).

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The mathematical model is based on the finite difference integration of the unsteady flow equations of two adjacent layers of fluids with different density. Calibration has been made by comparing computed results with measurements of salinity and level oscillations performed in the Adige River (N.E. Italy). A fairly good duplication of the experiments has been obtained by using a constant value for the friction coefficients, both on the interface and

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Stigebrandt, A. On the Effect of Barotropic Current Fluctuations on the Two-Layer Transport Capacity of a Constriction. JOURNAL OF PHYSICAL OCEANOGRAPHY, vol.7, No.1, p.118-122, January 1977. (See annotation in Section I.)

Suga, K. Salt-Wedge Intrusion with Entrainment. Proceedings, XVIth Congress of the International Association for Hydraulic Research, São Paulo, Brazil, July 27 to August 1, 1975, vol.4, Paper D22.

Practical way of estimation of saline water intrusion as in the state of salt-wedge into actual rivers is discussed in this paper. Peculiarity of the theory is the introduction of the effects of entrainment in the steady stratified non-uniform flows, on the assumptions that the salt water of the lower layer of constant concentration can only be intermixed into the upper layer where the saline element is completely mixed in a short distance. Analytical result is composed of four terms such as frictions, longitudinal density gradient, change of width and entrainment. Only the first term is considered in the most of the existing theories of salt water intrusion as in the stage of weak mixture. Functions of friction and entrainment were determined by large scale experiments and field observation. Calculated results show good agreement with actual data. The effect of entrainment was also discussed. References (4 items).

Sumer, S.M., and Fischer, H.B. Transverse Mixing in Partially Stratified Flow. Journal of the Hydraulics Division, Proc. ASCE, vol.103, No.HY6, p.587-600, June 1977. (See annotation in Section VI.)

Texas Water Development Board. Techniques for Evaluating the Effects of Water Resources Development on Estuarine Environments. Texas Department of Water Resources, LP-75, 1978. (See annotation in Section VI.)

Thatcher, M.L., and Harleman, D.R.F. Development and Application of a Deterministic Time-Varying Salinity Intrusion Model for the Delaware Estuary (MIT-TSIM). Prepared for the Delaware River Basin Commission, November 1978. 2 vols.

The study consists of the following parts. 1. A review of the MIT Transient Salinity Intrustion Model and a detailed modification of this model to make it a more sensitive and complete tool for predicting time-varying chloride concentrations in the Delaware Estuary. 2. A review of available geometric data and the selection of the most recent and complete data for the purpose of defining the estuary in numerical terms. 3. The integration of available boundary condition data from the NOS and USGS with techniques for estimating non-ocean chloride inputs. 4. The elaboration of sensitivity studies and calibration and verification studies in order to adjust the model to observed conditions in the estuary. 5. The application of the model for a period of 178 tidal cycles of water year 1965 conditions. 6. A final calibration/verification of the model using an entire year of observed data. References (44 items).

Trites, R.W., and Walton, A. A Canadian Coastal Sea - The Gulf of St. Lawrence. Bedford Institute of Oceanography, Dartmouth, Nova Scotia, Canada, Report Series BI-R-75-15, October 1975. (See annotation in Section VIII.)

Ulanowicz, R.E., and Flemer, D.A. A Synoptic View of a Coastal Plain Estuary. Hydrodynamics of Estuaries and Fjords; Proceedings of the 9th Liege Colloquium on Ocean Hydrodynamics, 1977, p.1-26. (See annotation in Section I.)

U.S. Army Corps of Engineers, Committee on Tidal Hydraulics. Unsteady Salinity Intrusion in Estuaries; Part I: One-Dimensional, Transient Salinity Intrusion with Varying Freshwater Inflow; Part II: Two-Dimensional Analysis of Time-Averaged Salinity and Velocity Profiles, by D.R.F. Harleman, J.S. Fisher, and M.L. Thatcher. Technical Bulletin No.20, July 1974.

The study reported herein is concerned with transient salinity intrusion and is presented in two parts. In Part I a one-dimensional numerical model is developed for the prediction of transient salinity intrusion under conditions of varying freshwater inflow. The model couples the one-dimensional continuity and momentum equation for unsteady tidal motion in a variable area estuary with the mass transport equation for salinity. The numerical model incorporates variable estuary geometry and roughness, time-dependent boundary conditions of tidal range at the ocean end, and variable freshwater inflow at the head of the estuary and from tributaries along the estuary. In this study the numerical model predictions are compared with salinity measurements in the WES salinity flume over a period of 25 tidal cycles during which time the freshwater flow was decreased at a uniform rate. The numerical model results have also been compared with field observations of transient salinity distribution in the Delaware, Potomac, and Hudson estuaries and a user's manual has been prepared. In Part II a two-dimensional analytical model is developed for the prediction of vertical distributions of velocity and salinity, averaged over a tidal period. The results of the numerical model described in Part I are used to determine the longitudinal salinity gradient which, for partially and well-mixed estuaries, is assumed to be independent of depth. The governing equations of the two-dimensional model are the vertical and longitudinal equations of motion, the equations of continuity and salt conservation, and an equation of state relating salinity and density. Dimensionless correlations, between mean vertical mass and momentum transfer coefficients and gross estuary characteristics, based on previous experimental data, are presented. These correlations are used to predict vertical velocity and salinity profiles for the WES salinity flume for the 25 tidal cycle tests with decreasing freshwater inflow. Comparisons of predicted and observed salinity and velocity profiles are given. References (12 items).

U.S. Army Engineer District, Philadelphia. Long Range Spoil Disposal Study. 7 parts in 8 vols., 1969-1973. (See annotation in Section II.)

U.S. Army Engineer Waterways Experiment Station. Effects of 40-Foot Charleston Harbor Project on Tides, Currents, and Salinities; Hydraulic Model Investigation, by H.A. Benson. Miscellaneous Paper H-76-9, May 1976. (See annotation in Section VI.)

U.S. Army Engineer Waterways Experiment Station. Model Studies of Navigation Improvements, Columbia River Estuary; Report 2: Entrance Studies; Section 4: Jetty A Rehabilitation, Jetty B, and Outer Bar Channel Relocation, by F.A. Herrmann, Jr. Technical Report No.2-735, Report 2, Section 4, July 1974. (See annotation in Section VI.)

U.S. Army Engineer Waterways Experiment Station. Neches River Saltwater Barrier, by C.J. Huval. Miscellaneous Paper H-74-9, August 1974.

A study of historical salinity data as a function of Federal channel deepening and freshwater withdrawals was conducted. On the basis of the data, a method of allocating relative effects on salinity intrusion of channel improvements and freshwater withdrawals was developed and applied to the Neches River. Literature Cited (6 items).

U.S. Army Engineer Waterways Experiment Station. Tillamook Bay Model Study; Hydraulic Model Investigation, by G.M. Fisackerly. Technical Report H-74-11, November 1974. (See annotation in Section VI.)

U.S. Geological Survey. A Numerical Model of Material Transport in Salt-Wedge Estuaries. Geological Survey Professional Paper 917, 1975. (See annotation in Section VI.)

Wang, Y.-H. The Interfacial Stress in a Strongly Stratified Estuary. Proceedings, XVIth Congress of the International Association for Hydraulic Research, São Paulo, Brazil, July 27 to August 1, 1975, vol.1, Paper A14.

A stable two-layer stratified flow is often found in the estuary (at least part of the year) where the fresh water from the river meets the ocean. In this case, the interfacial stresses τ_i are intimately related to the salinity intrusion length, internal circulation, salt balance and pollutant transport. Basic understanding of the mechanism and determination of the magnitude of the interfacial stresses are of practical and scientific importance. The present investigation is to study the longitudinal distribution of τ_i and to compare the interfacial stress coefficient f_i with laboratory measured value. References (10 items).

Ward, G.H., Jr. Formulation and Closure of a Model of Tidal-Mean Circulation in a Stratified Estuary. Estuarine Processes; Volume II, Circulation, Sediments, and Transfer of Material in the Estuary, edited by Martin Wiley. New York, Academic Press, 1977, p.365-378. (See annotation in Section VI.)

Ward, P.R.B. Measurements of Estuary Dispersion Coefficients. Journal of the Environmental Engineering Division, Proc. ASCE, vol.102, No.EE4, p.855-860, August 1976. (See annotation in Section I.)

Weel, M.A. van. Le Canal du Rhin a l'Escaut. Amenagements de l'Estuaire de l'Escaut (The Rhine-Scheldt Canal. Improvement Works in the Scheldt Estuary). Bulletin of the Permanent International Association of Navigation Congresses, No.17, p.37-41, 1974. (In French, English summary.) (See annotation in Section V.)

Welander, P. Two-Layer Exchange in an Estuary Basin, with Special Reference to the Baltic Sea. JOURNAL OF PHYSICAL OCEANOGRAPHY, vol.4, No.4, p.542-556, October 1974. (See annotation in Section I.)

Weston, A.E. The Measurement of Interactive Freshwater and Tidal Flows in the River Dee, North Wales. JOURNAL OF THE INSTITUTION OF WATER ENGINEERS AND SCIENTISTS, vol.33, No.1, p.69-79, January 1979. (See annotation in Section I.)

Williams, D.J.A., and West, J.R. Salinity Distribution in the Tay Estuary. The Royal Society of Edinburgh, Proceedings, Section B, vol.75, Parts 1/2, p.29-39, 1975.

Salinity distribution in the Tay Estuary measured during the years 1969-70 is influenced by freshwater flow and tidal range. Between Pool and Flisk, tidal-depth-mean salinity is a strong function of river flow but is much less influenced by tidal range. The relationship between salinity range (difference between maximum and minimum depth-mean salinities) and tidal range can be approximated by a linear function. The observed vertical salinity distribution varies with tidal state. The net non-tidal circulation has been estimated at Pool, Broughty Ferry, Newport, Balmerino and Flisk, and found to be dependent on river flow and position. References (25 items).

Wilson, R.E. Gravitational Circulation in Long Island Sound. ESTUARINE AND COASTAL MARINE SCIENCE, vol.4, No.4, p.443-453, July 1976. (See annotation in Section I.)

Winter, D.F. A Similarity Solution for Circulation in Stratified Fjords. International Symposium on Stratified Flows, Novosibirsk (U.S.S.R), 1972, Communication 29. (See annotation in Section I.)

Wollast, R. Modelling of Biological and Chemical Processes in the Scheldt Estuary. Hydrodynamics of Estuaries and Fjords; Proceedings of the 9th Liege Colloquium on Ocean Hydrodynamics, 1977, p.63-77. (See annotation in Section VI.)

Zimmerman, J.T.F. Dispersion by Tide-Induced Current Vortices. Hydrodynamics of Estuaries and Fjords; Proceedings of the 9th Liege Colloquium on Ocean Hydrodynamics, 1977, p.207-216. (See annotation in Section I.)

SECTION IV. CONTAMINATION

Contamination from sources such as industrial wastes or sewage, as distinguished from contamination by salt water.

Abbott, M.B., Dahl-Madsen, K.I., Hinstrup, P.I., et al. River and Estuary Modeling with the Siva System. Symposium on Modeling Techniques, 2nd Annual Symposium of the Waterways, Harbors and Coastal Engineering Division of ASCE, San Francisco, California, September 3-5, 1975, vol.I, p.745-763. (See annotation in Section VI.)

Aeration of the Thames. COMPRESSED AIR MAGAZINE, May 1972, p.12.

Brief account of the world's largest tidal river surface aerator built by the British firm Thames Board Mills, Ltd., to control its own effluent which is discharged into the Thames River.

Ages, A.B. A Numerical Model of Victoria Harbour to Predict Tidal Response to Proposed Hydraulic Structures. Environment Canada, Marine Sciences Branch, Pacific Region, Pacific Marine Science Report No.73-3, March 1973. (See annotation in Section VI.)

Amein, M., and Wardak, S.G. A Dynamic Water Quality Model for the Neuse Estuary, N.C. University of North Carolina, Sea Grant Program, Sea Grant Publication UNC-SG-75-28, December 1975. (See annotation in Section VI.)

Anderson, R.R. Remote Sensing of Marshlands and Estuaries Using Color Infrared Photography. Earth Resources Aircraft Program Status Review, Volume III - Hydrology, Oceanography, and Sensor Studies, Section 26; Presented at the NASA Manned Spacecraft Center, Houston, Texas, September 16 to 18, 1968. (See annotation in Section VII.)

Anderson, R.R. The Use of Color Photography in Marshland and Estuarine Studies. In New Horizons in Color Aerial Photography; A Seminar sponsored by The American Society of Photogrammetry and The Society of Photographic Scientists and Engineers, June 9-11, 1969, p.281-288. (See annotation in Section VII.)

April, G.C., Hill, D.O., and Liu, H.-A. Hydrodynamic and Material Transport Model for Mobile Bay, Alabama. Symposium on Modeling Techniques, 2nd Annual Symposium of the Waterways, Harbors and Coastal Engineering Division of ASCE, San Francisco, California, September 3-5, 1975, vol.I, p.764-782. (See annotation in Section VI.)

Arthur, J.F. Preliminary Studies on the Entrapment of Suspended Materials in Suisun Bay, San Francisco, Bay-Delta Estuary. Proceedings of a Workshop on Algae Nutrient Relationships in the San Francisco Bay and Delta, held November 8-10, 1973, at Clear Lake, California, p.17-36. The San Francisco Bay and Estuarine Association, 1975. (See annotation in Section VIII.)

Barailler, L. Aménagement de l'estuaire de la Seine. Rejets de gypse en conduite (Development of the Seine Estuary. Discharge of a Gypsum from a Pipe). LA HOUILLE BLANCHE, vol.29, No.1/2, p.67-70, 1974. (In French.)

In 1972 a study was made of the possible effects of gypsum discharge on the water and bed of the estuary: (i) investigation of two-dimensional convection in the downstream part of the estuary by observation of float movements on a scale model. (ii) Calculation of one-dimensional convection in the upstream part of the estuary. With discussion.

Bard, H., and Krutchkoff, R.G. A Stochastic Model for the James. Virginia Polytechnic Institute and State University, *Blacksburg*, *Water Resources* Research Center, August 1973. (See annotation in Section I.)

Barrett, M.J., and Mollowney, B.M. Pollution Problems in Relation to the Thames Barrier. Philosophical Transactions of the Royal Society of London, Mathematical and Physical Sciences, vol.272, No.1221, p.213-221, May 4, 1972. (See annotation in Section VI.)

Basu, A.N. Inclusion of Actual Bed Slope of a Tidal River in Hydrodynamical Model. In: Proceedings, Forty-Fourth Annual Research Session, Chandigarh, 29 January - 1 February 1975, Volume II - Hydraulics. Central Board of Irrigation and Power (India), Publication No.123, January 1975, p.128-133. (See annotation in Section I.)

Benson, C.A., Hann, R.W., Jr., and Reynolds, T.W. Analytical Models for the Evaluation of Supplemental Aeration in Texas Estuaries. Texas A&M University, Environmental Engineering Division, Sea Grant College, TAMU-SG-75-213, January 1976. (See annotation in Section VI.)

Billen, G. Nitrification in the Scheldt Estuary (Belgium and The Netherlands). ESTUARINE AND COASTAL MARINE SCIENCE, vol.3, No.1, p.79-89, January 1975.

Nitrification and repartition of nitrifying bacteria were investigated in the autoepuration zone of the Scheldt estuary. Measurements of vertical profiles of nitrate and nitrite concentration in the interstitial water of sediments show that nitrification in sediments is very low, implying that most of the nitrate and nitrite production occurs in the water of the river itself. Nitrifying bacteria, probably of terrestrial origin, are present throughout the water along a longitudinal profile of the estuary, with a regular decrease in numbers downstream. However, nitrification occurs only in a zone of favourable oxidation-reduction conditions, which coincides with the thermodynamic stability fields of nitrate and nitrite with respect to ammonium. References (28 items).

Billen, G., and Smitz, J. Mathematical Model of Water Quality in a Highly Polluted Estuary. Hydrodynamics of Estuaries and Fjords; Proceedings of the 9th Liege Colloquium on Ocean Hydrodynamics, 1977, p.55-62. (See annotation in Section VI.)

Bioindicators of Pollution; Volume 2. November 1977-October 1978: A Bibliography with Abstracts. Elizabeth A. Harrison, Editor. National Technical Information Service NTIS/PS/1143, October 1978.

Cites abstracts relating to the use of microorganisms, animals, plants, and fishes to detect air and water pollution. Some of the organisms discussed are algae, bacteria, aquatic plants, oysters, snails, clams, insects, annelida, amphibians, beavers and fungi. The updated bibliography contains 43 abstracts, all of which are new entries to the previous edition.

Boericke, R.R., and Hogan, J.M. An X-Z Hydraulic/Thermal Model for Estuaries. Journal of the Hydraulics Division, Proc. ASCE, vol.103, No.HY1, p.19-37, January 1977. (See annotation in Section VI.)

Bonz, P.E. Fabric Boom Concept for Containment and Collection of Floating Oil. U.S. Environmental Protection Agency, Environmental Protection Technology Series, EPA-670-2-73-069, September 1973. (See annotation in Section V.)

Bowman, M.J. Spreading of the Hudson River Effluent into the New York Bight. Hydrodynamics of Estuaries and Fjords; Proceedings of the 9th Liege Colloquium on Ocean Hydrodynamics, 1977, p.373-386. (See annotation in Section I.)

Bowman, M.J. Tidal Locks Across the East River: An Engineering Solution to the Rehabilitation of Western Long Island Sound. In: Estuarine Processes. Volume I: Uses, Stresses, and Adaptation to the Estuary; Edited by Martin Wiley; Academic Press, New York, San Francisco, London, 1976, p.28-43.

Water quality in western Long Island Sound and New York Harbor is seriously degraded. A major source of pollutants is sewage released into the East River, a cooscillating tidal strait connecting the Sound to the Harbor. Very rapid and significant improvements in water quality could be attained by constructing ship locks across the Upper East River to increase the circulation of the sea through the Harbor and Sound. During ebb tide these locks would be opened, allowing an unhindered flow of Sound water into the Harbor. After six hours the locks would be closed at slack water, blocking the following flood tide from re-entering the Sound. The net result would be a strong pulsating unidirectional flow (~2500 m^3 sec^{-1}) of relatively clean central Long Island Sound water, pumped by the semi diurnal tides through New York Harbor, and the Lower Bay, out into the New York Bight. Simple models indicate that the concentration of conservative contaminants in the western Sound and the Harbor would drop by ~88% and ~45%, respectively, from present levels, within a month of operation. The accompanying decreases in inorganic nutrient concentrations are calculated and tabulated for both winter and summer conditions. The major physical effects of blocking Hudson River water from entering the Sound through the East River would be to change the essential estuarine characteristics of western Long Island Sound to those of a coastal embayment, and increase the salinity of the western Sound and New York Harbor both by ~4°/oo. References (34 items).

Brandes, R.J., and Masch, F.D. Estuarine Ecologic Simulations. Symposium on Modeling Techniques, 2nd Annual Symposium of the Waterways, Harbors and Coastal Engineering Division of ASCE, San Francisco, California, September 3-5, 1975, vol.I, p.159-178. (See annotation in Section VI.)

Bray, T.J. Chesapeake Area, Fearing a Ruined Bay, Strives to Balance Ecology and Growth. WALL STREET JOURNAL, September 17, 1975, p.42.

The Chesapeake Bay is in danger of serious deterioration if present trends continue. Some threatening signs include: (1) the toxicity of Baltimore Harbor grows from years of accumulated wastes dumped by ships, industries, and municipalities; (2) a number of important tributaries show signs of increasing eutrophication; and (3) fishing yields have dropped significantly. More than 8 million people now live in the bay area, and rapid growth is expected to continue.

Brooks, N.H. Dispersion in Hydrologic and Coastal Environments. W.M. Keck Laboratory of Hydraulic and Water Resources, California Institute of Technology, Report No.KH-R-29, December 1972. Same: U.S. Environmental Protection Agency, Pacific Northwest Environmental Research Laboratory, Report EPA 660/3-73-010, August 1973. 136p.

Laboratory research results are presented relevant to dispersion of pollutants in hydrologic and coastal environments. Results for buoyant jets are relevant to design of outfalls in oceans, estuaries, etc., and special emphasis is given to slot jets representing long multiple-outlet-diffusers. Results for density stratified reservoirs enable predictions of selective withdrawal to be made. A simulation procedure for predicting reservoir mixing by systems pumping from one level to another is included. Observations of transverse mixing of tracer flows were made for application to rivers and estuaries. References, reports, etc., p.95-136.

Brown, R.J. Water Pollution in Estuaries and Coastal Zones; A Bibliography with Abstracts. National Technical Information Service, Springfield, Va., September 1975.

The bibliography contains selected abstracts of research reports covering studies dealing with water pollution from estuarine and coastal development, the effects of this pollution, and its control. The reports are general in nature so as to be of interest to any coastal area. The topics include pollution as related to urbanization, government actions, coastal planning, natural resource development, and sewage and solid waste disposal. Specific biological and oceanographic studies have been excluded. (Contains 214 abstracts.)

Brown, R.J. Water Pollution in Estuaries and Coastal Zones. Volume I. 1964 - 1974. A Bibliography with Abstracts. National Technical Information Service, NTIS/PS-76/0851, November 1976.

The bibliography contains selected abstracts of research reports covering studies dealing with water pollution from estuarine and coastal development, the effects of this pollution, and its control. The reports are general in nature so as to be of interest to any coastal area. The topics include pollution as related to urbanization, government actions, coastal planning, natural resource development, and sewage and solid waste disposal. Specific biological and oceanographic studies have been excluded. (This updated bibliography contains 165 abstracts.)

Brown, R.J. Water Pollution in Estuaries and Coastal Zones. Volume 2. 1975 - September 1976. A Bibliography with Abstracts. National Technical Information Service, NTIS/PS-76/0852, November 1976.

The bibliography contains selected abstracts of research reports covering studies dealing with water pollution from estuarine and coastal development, the effects of this pollution, and its control. The reports are general in nature so as to be of interest to any coastal area. The topics include pollution as related to urbanization, government actions, coastal planning, natural resource development, and sewage and solid waste disposal. Specific biological and oceanographic studies have been excluded. (This updated bibliography contains 145 abstracts, 96 of which are new entries to the previous edition.)

Carder, K.L., Palmer, S.L., Rodgers, B.A., et al. Calibration of a Thermal Enrichment Model for Shallow, Barricaded Estuaries. University of South Florida, St. Petersburg, Department of Marine Science, September 1976. (See annotation in Section VI.)

Carlton, D.T. Energy Dispersive X-Ray (EDX) Spectroscopy. Second Joint Conference on Sensing of Environmental Pollutants, Washington, D.C., December 10-12, 1973, p.49-51. (See annotation in Section VII.)

Carruthers, J.N. A Prototype Totalising Current-Meter (Mark II); A Self-Moored Version for Near-Surface Use Especially in Foul Water Estuaries in Connection

with Pollutant Dispersal Studies. Bulletin, Institut Oceanographique, Monaco, vol.70, No.1418, 1972. (See annotation in Section VII.)

Carter, H.H. The Distribution of Excess Temperature from the Morgantown Generating Station on the Potomac Estuary. Chesapeake Bay Institute, The Johns Hopkins University, Technical Report 84, Reference 73-10, October 1973. (See annotation in Section VIII.)

Carter, H.H. Simple One Dimensional Kinematic Model Results for the Bush River and Romney Creek. Chesapeake Bay Institute, The Johns Hopkins University, Special Report 49, Reference 76-2, March 1976. (See annotation in Section VI.)

Chapra, S.C., and Nossa, G.A. Documentation for HARO3. A Computer Program for the Modeling of Water Quality Parameters in Steady State Multi-dimensional Natural Aquatic Systems. Second Edition. U.S. Environmental Protection Agency, New York, October 1974.

HARO3 is a computer program which can be used to model the steady-state distribution of water quality variables for multi-dimensional bodies of water. The technique underlying the program is based on the conservation of mass and up to two variables reacting in a feed forward fashion with first order kinetics may be modeled. This program was developed for analysis of the Biochemical Oxygen Demand (BOD) - Dissolved oxygen system, but with minor modifications the program can be used to model analogous variables such as chlorides, phosphates, coliform bacteria, etc. References (12 items).

Chatwin, P.C., and Sullivan, P.J. How Some New Fundamental Results on Relative Turbulent Diffusion Can Be Relevant in Estuaries and Other Natural Flows. Hydrodynamics of Estuaries and Fjords; Proceedings of the 9th Liege Colloquium on Ocean Hydrodynamics, 1977, p.233-242.

The paper deals with the relative turbulent diffusion of a cloud of passive contaminant, and in particular with the ensemble mean concentration $C(\underline{y},t)$ and the statistics of the fluctuation of concentration $c(\underline{y},t)$. Recent work by the authors, using the fundamental equations (without eddy diffusivities), has led to results which are in many ways quite different from those presented, e.g. in Csanady (1973). Among those results summarized here are new estimates of the magnitude of C and $\overline{c^2}$ throughout the cloud, a proposal that there is a small core region surrounding the centre in which both C and $\overline{c^2}$ are much larger than elsewhere, a physical explanation of how the distributions of C, $\overline{c^2}$ and certain correlations and spectra can be self-similar outside the core in isotropic turbulence, and some speculations about the profound role of molecular diffusion. Some experimental confirmation of the physical picture leading to these results has also been obtained. The main part of the present paper is an examination of how far these results can be used in the complicated velocity fields occurring in estuaries and other natural flows. In particular, certain time scales are obtained which measure departures of the velocity field in the neighborhood of the cloud from isotropy, homogeneity and statistical stationarity. It is argued that for times since release less than the smallest of these, the effects of anisotropy, inhomogeneity and statistical unsteadiness of the velocity field on the dispersion of the cloud can be incorporated in the description summarized above. For the Tay estuary this minimum time is about 3 hours. References (17 items).

Chen, C.W., Smith, D.J., Jackson, J.D., et al. Organic Sediment Model for Wastewater Outfall. Symposium on Modeling Techniques, 2nd Annual Symposium of the Waterways, Harbors and Coastal Engineering Division of ASCE, San Francisco, California, September 3-5, 1975, vol.I, p.179-207. (See annotation in Section VI.)

Chesapeake Research Consortium, Inc., The. The Effects of Tropical Storm Agnes on the Chesapeake Bay Estuarine System. The Johns Hopkins University Press, Baltimore and London, CRC Publication No.54, November 1976. (See annotation in Section VIII.)

Chevereau, G , Montaz, J.P., and Crouzet, P.H. Modèle mathematique de pollution par convection d'un traceur conservatif; Son utilisation dans l'étude de l'assainissement du Golfe du Morbihan. Proceedings, XVI Congress of the International Association for Hydraulic Research, São Paulo, Brazil, July 27 to August 1, 1975, vol.4, Paper D21. (In French.) (See annotation in Section VI.)

Codell, R.B. Digital Computer Simulation of Thermal Effluent Dispersion in Rivers,

Lakes, and Estuaries. U.S. Army Missile Research, Development and Engineering Laboratory, Redstone Arsenal, Alabama, Technical Report RS-73-16, 5 November 1973.

The purpose of this work was to illustrate that the dispersion of effluent from thermal power plants discharging into bodies of water could be realistically simulated on a digital computer. The basic equations for the conservation of mass, momentum, and thermal energy in three dimensions were simplified and vertically integrated into different forms depending on whether the discharge was of the thermally stratified or well mixed type. Numerical algorithms were devised to solve the finite difference representations of the simplified conservation equations within the limits of present day digital computers. Extensive linear stability analysis was performed to assure the validity and stability of the numerical solutions. The stratified flow model assumes two distinct layers, an upper thermal layer and a lower ambient layer either stagnant or flowing. The nonstratified model is useful for cases of large bodies of water where there is severe mixing and no appreciable stratification. In both models, the boundaries of the computational grid are completely general and are able to simulate arbitrary shorelines and discharge configurations. References (34 items).

Collett, W.F. The Quality of the Forth Estuary. The Royal Society of Edinburgh, Proceedings, Section B., vol.71, Parts 2/4, p.137-141, 1972.

The Forth Estuary is divided into 2 parts, the narrow part to the W of Queensferry in which there is a substantial tidal variation in salinity, and the broader part, which is virtually open sea, to the E of Queensferry. The quality of the narrow part of the Forth is assessed largely by general physical and chemical observations without extensive biological appraisal. The quality is largely determined by discharge of degradable organic matter in the form of sewage, sewage effluents and trade effluents, the bacterial oxidation of which deoxygenates the water, according to the combination of freshwater flow, meteorological conditions, and the monthly tide cycle. The condition may be aggravated by thermal waste discharge. In the broader part of the estuary, pollution is limited to the littoral zone. There is local beach pollution from sewage solids; mining pollution, in the form of washery slurry pit redd and ferruginous pit waters, has extensively affected conditions over a 6-mi stretch of shore.

Conomos, T.J. Movement of Spilled Oil as Predicted by Estuarine Nontidal Drift. LIMNOLOGY AND OCEANOGRAPHY, vol.20, No.2, p.159-173, March 1975.

Information on water movement obtained from bimonthly releases of surface and seabed drifters in the San Francisco Bay and adjacent Pacific Ocean is used to understand major processes controlling dispersal of oil after a spill of 3,200 m^3 of Bunker C in the bay in January 1971. River-induced nontidal estuarine circulation was the dominant factor controlling net movement of the oil spilled at the entrance of the bay system, reinforcing ebbing tidal currents and causing the seaward movement of floating oil, which followed paths taken by surface drifters released 3 weeks before the spill. In contrast, some oil formed globules which sank to the near-bottom waters, had the same relative buoyancy as seabed drifters, and moved similarly, beaching in eastern San Pablo Bay after being transported landward in the near-bottom waters. No oil or surface drifters floated into the south bay because surface waters were drifting seaward, away from the south bay. Notable seasonally modulated phenomena which must be considered in predicting surface and near-bottom oil drifts of future spills include a summer (low-river discharge period) diminution of the estuarine circulation mechanism in the north and central bay-adjacent ocean region and a seasonal reversal in two-layer drift in the south bay. References (37 items).

Conti, U. Water Pollution Monitoring. INDUSTRIAL PHOTOGRAPHY, vol.21, No.7, p.30-31, 49, July 1972. (See annotation in Section VII.)

Cook, C.E., Bridge, M.L., Brooks, T.J., III, et al. The Delineation of and Factors Affecting Mississippi Coastal Estuaries and Tidal Marshes. University of Mississippi, Department of Urban and Regional Planning, November 1971. Sea Grant Publication No.MSGP-71-002.

Adequate controls for the maintenance of the environmental quality of the coastal zone of Mississippi do not presently exist. A study was conducted to determine the feasibility of environmental controls, with particular emphasis on protection of the aesthetic values, quality of living, and economic welfare of the coastal zone. State assistance is needed to establish a political arrangement which will foster conservation and good development. The creation of a state planning authority, authorized to

conduct research, coordinate planning, and enforce laws which override private or local actions, is recommended. Bibliography (29 items).

Covill, R.W. The Quality of the Forth Estuary - Lothians Area. Paper presented at the 18th Meeting of the Institute of Environmental Sciences, New York, May 1-4, 1972, Proceedings, p.53-59.

Data demonstrate gross pollution existing in inshore waters of the Firth of Forth estuary, Scotland. (14 diagrams, 7 graphs, 2 tables)

Covill, R.W. The Quality of the Forth Estuary. The Royal Society of Edinburgh, Proceedings Section B, vol.71, Part 2/4, p.143-170, 1972.

Details of the volumes of known sources of pollution, and chemical, bacteriological, and biological data from a 1958 survey emphasized the estuary to be grossly polluted. Data from a similar survey in 1962 indicated continued deterioration of conditions, in particular lower DO concentrations of inshore waters and the increase in coliform counts and the presence of Salmonella species. The effect of relatively high concentrations of heavy metals on the ecology of the estuary has yet to be fully assessed. Sewage discharges tend to be confined to inshore waters resulting in pollution of certain beaches. A continued monitoring program is indicated. The legal position relative to the control of discharges to the Forth Estuary is also presented. References to Literature (2 items).

Crean, P.B. A Numerical Model of Baratropic Mixed Tides Between Vancouver Island and the Mainland and Its Relation to Studies of the Estuarine Circulation. Hydrodynamics of Estuaries and Fjords, Proceedings of the 9th Liege Colloquium on Ocean Hydrodynamics, 1977, p.283-313. (See annotation in Section III.)

Cronin, L.E., Pritchard, D.W., Koo, S.Y., et al. Effects of Enlargement of the Chesapeake and Delaware Canal. Estuarine Processes, Volume II, Circulation, Sediments, and Transfer of Material in the Estuary, edited by Martin Wiley. New York, Academic Press, 1977, p.18-32. (See annotation in Section I.)

Daiber, F.C. Flushing Pattern of Certain Tidal Streams in Delaware. Project Completion Report to Office of Water Resources Research, Department of the Interior, January 1972. (See annotation in Section I.)

Daniell, T.M. The Current Essentials of Dispersion and Diffusion. First Australian Conference on Coastal Engineering, Sydney, May 14-17, 1973; Engineering Dynamics of the Coastal Zone, p.151-158. (See annotation in Section I.)

Daubert, A. La dispersion dans les écoulements filaires (Filament Flow Dispersion). LA HOUILLE BLANCHE, vol.29, No.1/2, p.47-54, 1974. (In French.) (See annotation in Section I.)

Daubert, A., and Malherbe, J.-F. Evaluation de la capacité de réfrigération d'un estuaire. Exemple de la Loire (Calculating the Cooling Capacity of an Estuary. Example of the Loire Estuary). LA HOUILLE BLANCHE, vol.29, No.1/2, p.35-46, 1974. (In French.)

An analysis of the thermal equilibrium of an estuary under the influence of a power plant of a given output shows the water temperature rise to depend on the absorbed power ratio between the sea and atmosphere. This ratio in turn depends on power station position, hydraulic conditions in the estuary, and dispersive capacity of the estuary, which increases exchange effects with the sea. A one-dimensional model is described, which allows for all these parameters and serves to compute the temperature rise. It comprises two parts, one reproducing the effect of tide and river flow on convection in the estuary and the other reproducing heat transfer by convection and dispersion and heat loss to the sea and atmosphere. Calculation examples for the Loire estuary show the effect of dispersion. References (7 items).

Davidson, B. Process Control Model for Oxygen Regeneration of Polluted Rivers, Phase II. Water Resources Research Institute, Rutgers University, New Brunswick, N.J., April 1971. (See annotation in Section VI.)

Davidson, B. Process Control Model for Oxygen Regeneration of Polluted Rivers, Phases IV and V; and Spatially and Temporally Distributed Discharge of Effluents in Estuaries. Water Resources Research Institute, Rutgers University, New Brunswick, N.J., January 1974. (See annotation in Section VI.)

Davidson, B., and Hunter, J.V. Process Control Model for Oxygen Regeneration of Polluted Streams (Phase I). Water Resources Research Institute, Rutgers University, Brunswick, N.J., Research Project Technical Completion Report, March 1970. (See annotation in Section VI.)

De Guida, R., Connor, J.J., and Pearce, B. Application of Estimation Theory to Design of Sampling Programs for Verification of Coastal Dispersion Predictions. Massachusetts Institute of Technology, Sea Grant Program, Report No.MITSG 76-16, November 20, 1976. (See annotation in Section I.)

Devenis, K.P. Programs to Improve Water Quality on the Lower Charles. Reprint from Journal of the New England Water Pollution Control Association, vol.7, No.2, p.183-192, December 1973.

The construction of the new Charles River Dam, proposed improvements in Back Bay Fens, and the Charles River Estuary project are described. Other projects briefly summarized are the construction of relief sewers along the south side of the Charles River, relief sewers along the north side of the Charles River in Cambridge, the Cottage Farm storm water treatment station, a 5-yr pollution relief program of the city of Cambridge, repair to tide gates within the city of Boston, separation of combined sewerage systems within the town of Brookline, and installation of waste water treatment plants along the Upper Charles River.

DeWitt, P., and Daiber, F.C. The Hydrography of the Broadkill River Estuary, Delaware. CHESAPEAKE SCIENCE, vol.14, No.1, p.28-40, March 1973. (See annotation in Section VIII.)

Dinelli, G., and Castellano, L. Design for Thermal Effluents in Rivers. Journal of the Hydraulics Division, ASCE, vol.105, No.HY3, p.197-211, March 1979. (See annotation in Section VI.)

Downing, A.L. Forecasting the Effects of Polluting Discharges on Natural Waters -- I. Rivers. INTERNATIONAL JOURNAL OF ENVIRONMENTAL STUDIES, vol.2, No.2, p.101-110, 1971.

Methods used by the Water Pollution Research Laboratory to predict the effects of polluting discharges on rivers are described. The shortcomings of the methods at present available are discussed, and possible ways in which these may be modified are outlined. The simple mass-balance of pollutants is considered first, and examples are given of situations in which this technique can be usefully employed. The prediction of the behavior of discharges of conservative substances is then described and extended from the calculation of average concentrations to the consideration of probable variations in concentration. The additional complications involved when considering the more usual situation where the discharge contains non-conservative substances are outlined, and the difficulties inherent in the prediction of dissolved-oxygen concentration are described. Finally the problems of accidental and intermittent discharges are discussed. References (6 items).

Downing, A.L. Forecasting the Effects of Polluting Discharges on Natural Waters -- II. Estuaries and Coastal Waters. INTERNATIONAL JOURNAL OF ENVIRONMENTAL STUDIES, vol.2, No.3, p.221-226, November 1971.

A brief account is given of the present state of development of methods for forecasting the effects of pollution on estuaries and coastal waters. In the case of vertically homogeneous estuaries the concentration of given pollutants at a chosen state of tide and given freshwater flow can be determined by means of a one-dimensional steady-state mathematical model in which use is made of observations of the distribution of salinity to calculate the rate of dispersion of the pollutants. An example is given of the application of such a model to the prediction of the concentration of dissolved oxygen, ammonia and oxidized nitrogen in the Thames Estuary. This type of approach has been extended to allow approximate estimates to be made of the variation of concentration of pollutants during a tidal cycle, and of the steady-state concentrations in vertically stratified estuaries. A somewhat different type of model is used for predicting the effects of polluting discharges on coastal waters and in this case dispersion characteristics are determined with the aid of radio isotopes. An example is given of the application of one type of model to the prediction of the contamination of coastal waters by coliform bacteria resulting from discharge of sewage from a submerged pipeline. References (3 items).

Drapeau, G., Harrison, W., Bien, W., et al. Oil Slick Fate in a Region of Strong Tidal Currents. Proceedings of the Fourteenth Coastal Engineering

Conference, June 24-28, 1974, Copenhagen, Denmark, vol.III, 1975, Chapter 130 (p.2245-2259).

This study examines the drifting, spreading and aging of small slicks of crude oil in the middle St. Lawrence Estuary. This region was chosen because it is well documented with field measurements, hydraulic scale models, and mathematical models; and also because it is becoming a strategic area for the development of supertanker ports for 300,000 and possibly 500,000 ton tankers. Two controlled releases of Venezuelan crude (370 and 800 litres) were made in November 1972, as ice began to form in the St. Lawrence Estuary. The experiments were supported by the Canada Centre for Remote Sensing which carried out extensive airborne monitoring. The results indicate that it is impossible either to recover or to disperse small spills of oil in this region of strong tidal currents. Models also predict slick motion poorly. The alternative is to construct slick-drift roses that will indicate areas of expected beaching and assist in deployment of oil-spill clean-up technology. References (11 items).

Dredging Seminar, 9th, Texas A&M University, College Station, Texas, 1976. Proceedings . . . supported by the Oceanic and Atmospheric Administration's Sea Grant Program and the Center for Dredging Studies, Texas A&M University. Texas A&M University, Sea Grant College, TAMU-SG-77-115; Center for Dredging Studies, Report No.206, October 1977.

Contents: Stabilization of Coastal Subaerial Dredged Material Sites in North Carolina, by M. Siipola. Availability of Sediment-Absorbed Heavy Metals to Benthic Deposit-Feeding Organisms, by J.F. Slowey. Feasibility of Developing Biological Habitats on Dredged Material, by H.K. Smith. Mining of Phosphates by Dredge, by D.M. Frazier. Techniques for Reducing Turbidity with Present Dredging Procedures and Operations, by John Huston. The Future of the Dredging Market, by C.B. Hakenjos. Selected Environmental Aspects of Dredging in San Diego Bay, California, by D.D. Smith. Corbicula Manilensis Phillipi in the Arkansas River: Should the Corps of Engineers be Concerned?, by L.R. Kraemer. Cost-Effectiveness Analysis of Solids-Liquid Separation Alternatives in Dredged Material Disposal Operations, by M.J. Hoffman. Research to Dewater Dredged Material, by T.A. Haliburton. Primary Consolidation and Compressibility of Dredgings, A.M. Salam. Stabilization of Polluted Dredgings by Electro-Osmosis, by R.J. Krizek.

Dubach, H.W., Compiler. The North Carolina Coastal Zone and Its Environment; A Compilation of Resource Materials Covering the Coastal Plain, Estuaries, and Offshore Waters. Savannah River Laboratory, Aiken, South Carolina, DP-1423, November 1977. 2 vols. (See annotation in Section II.)

Ecker, R.M., and Hendricks, J.W. Factors Affecting the Distribution of Contaminants in an Estuary. In: Dredging: Environmental Effects & Technology; Proceedings of WODCON VII, San Francisco, California, July 10-12, 1976, p.69-84.

Dredging navigation channels in San Francisco Bay involves in many cases fine sediments contaminated with organics and inorganics. Dredging and disposal operations disturb and displace these contaminated sediments which are then subjected to the distributing forces. The San Francisco District has been conducting a study of the horizontal and vertical distribution of contaminants in sediments of the San Francisco Bay system and the distributing forces responsible for the distribution. This paper discusses the comparative pollutional status of sediments in selected areas inside and outside navigation channels and the factors responsible for the varying contaminant concentrations.

Elliott, A.J. Methods for Determining the Concentrations and Sources of Pollutants in Estuaries. Chesapeake Bay Institute, The Johns Hopkins University, Special Report 50, Reference 76-3, April 1976. (See annotation in Section VI.)

Elliott, A.J. A Steady State Two-Layered Noncoupled Dynamic and Kinematic Estuarine Model with Application to the Potomac Estuary. Chesapeake Bay Institute, The Johns Hopkins University, Special Report 44, Reference 75-6, July 1975. (See annotation in Section VI.)

Emerson, R.R. Heavy Metal Concentrations in Marine Organisms and Sediments Collected near an Industrial Waste Outfall. Proceedings of the International Conference on Environmental Sensing and Assessment, Las Vegas, Nevada, September 14-19, 1975, vol.I. (See annotation in Section II.)

Fang, C.S., Parker, G., and Harrison, W. Hydrothermal Monitoring: Surry Nuclear Power Plant. Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, Copenhagen, Denmark,

vol.III, 1975, Chapter 143 (p.2431-2450). (See annotation in Section VII.)

Farraday, R.V., O'Connor, B.A., and Smith, I.M. Galerkin Finite Element Solutions for Pollution Problems in Partially Mixed Estuaries. Paper presented at the International Symposium on Finite Element Methods in Flow Problems, edited by J.T. Oden, O.C. Zienkiewicz, R.H. Gallagher, and C. Taylor, The University of Alabama at Huntsville, 1974, p.399-400. (See annotation in Section VI.)

Farraday, R.V., O'Connor, B.A., and Smith, I.M. A Two-Dimensional Finite Element Model for Partially Mixed Estuaries. Proceedings, XVIth Congress of the International Association for Hydraulic Research, São Paulo, Brazil, July 27 to August 1, 1975, vol.3, Paper C31. (See annotation in Section VI.)

Ferrari, F. Considerations on the Stability of a Tidal Lagoon Under Conditions of Inflow and/or Outflow of a Thermoelectric Power Plant-Cooling Water Circuit. Proceedings, XVIth Congress of the International Association for Hydraulic Research, São Paulo, Brazil, July 27 to August 1, 1975, vol.1, Paper A10. (See annotation in Section VI.)

Fischer, H.B. The Effect of Estuarine Circulation on Pollution Dispersal. U. S. Environmental Protection Agency, Office of Water Planning and Standards, Estuarine Pollution Control and Assessment; Proceedings of a Conference, vol.II, p.477-485, March 1977. (See annotation in Section I.)

Fischer, H.B. Mixing and Dispersion in Estuaries. In: Annual Review of Fluid Mechanics, edited by Milton Van Dyke, W.G. Vincenti, and J.V. Wehausen, vol.8, p.107-133, 1976. (See annotation in Section I.)

Fischer, H.B. Numerical Modelling of Dispersion in Estuaries. Proceedings of the International Symposium on Discharge of Sewage from Sea Outfalls, held in London August 27 - September 2, 1974, Paper No.37 (p.371-380); Edited by A.L.H. Gameson, Water Research Centre, U.K., Pergamon Press, 1975. (See annotation in Section VI.)

Fisher, J.J. Criteria for Recognition of Estuarine Water Pollution by Aerial Remote Sensing. University of Rhode Island, Technical Completion Report, Project No. OWRR: A-031-RI, 1970. (See annotation in Section VII.)

Flugge, G., and Schwarze, H. Similarity Conditions for Thermal-Hydraulic Model Tests of Tidal Estuaries. Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, Copenhagen, Denmark, vol.III, 1975, Chapter 142 (p.2421-2430). (See annotation in Section VI.)

Forth-Tay Estuaries, The (An Environmental Assessment). Papers, Symposium held in the Rooms of the Royal Society of Edinburgh, October 29, 1971. In: The Royal Society of Edinburgh, Proceedings, Section B, vol.71, Parts 2/4, p.97-226, 1972. (See annotation in Section VIII.)

Fussell, D.R., Jagger, H., Johnes, G.L., et al. Control of Oil Pollution in Coastal Waters. Ninth World Energy Conference, Detroit, September 22-27, 1974, Paper 2.2-4.

Man-caused, petroleum-derived hydrocarbon release is concentrated around industrialized land masses and major shipping routes, both of which contribute to coastal pollution. Oil reaching the sea is removed continuously by such routes as evaporation, photochemical oxidation, and hydrocarbon degrading bacteria that alleviate the effects of even heavy contamination of beaches; nevertheless, this type of pollution still causes the greatest offense to people. Various efforts made to reduce oil discharge are discussed. Development of chemicals and equipment to relieve the effects of spilt oil is presented. One major problem is measuring quantitatively the extent of any improvements that, at present, are based largely on subjective judgments. Steps taken to reduce oil pollution must be soundly based so as to avoid wasteful expenditure of materials and manpower (1 graph, 2 maps, 28 refs, 1 table). Bibliography (28 items).

Gibbs, R.J. Distribution and Transport of Suspended Particulate Material of the Amazon River in the Ocean. Estuarine Processes, Volume II, Circulation, Sediments, and Transfer of Material in the Estuary, edited by Martin Wiley. New York, Academic Press, 1977, p.35-47. (See annotation in Section II.)

Gordon, R. and Spaulding, M. A Bibliography of Numerical Models for Tidal Rivers, Estuaries and Coastal Waters.

University of Rhode Island, Marine Technical Report 32; Ocean Engineering, NOAA Sea Grant, 1974. (See annotation in Section VI.)

Great Britain, Water Research Centre, Stevenage Laboratory. One-Dimensional Models of Estuarine Pollution. Notes on Water Pollution No.69, June 1975.

Models are presented for the prediction of the distribution of a soluble pollutant from a knowledge of the amount entering the estuary and given environmental conditions. The distributions after 2 different periods of a fortnight, in one of which the flow was increasing and in the other decreasing, were predicted with considerable accuracy by a quantized mixing model developed for predicting the effects of pollution on the water of the Thames Estuary. By considering the exchange of water across a boundary it can be shown that a similar symmetrical distribution at each section would lead to a net transfer of water across the boundary by mixing alone. A mixed-segment model, equivalent to the eddy-diffusion model, was developed to assess the likely effect of the operation of the Thames Barrier on estuarine water quality. Values for the mixing constants are derived by adjusting them until the calculated salinities agree as well as possible with those observed. Time-dependent and time-averaged variations of this model are given. References (8 items).

Grenney, W.J., Porcella, D.B., and Cleave, M.L. Water Quality Relationships to Flow -- Streams and Estuaries. In: Methodologies for the Determination of Stream Resource Flow Requirements: An Assessment, edited by C.B. Stalnaker and J.L. Arnette; Utah State University, Logan, 1976, p.35-88. (See annotation in Section VI.)

Gross, M.G. Effects of Waste Disposal Operations in Estuaries and the Coastal Ocean. In Annual Review of Earth and Planetary Sciences, vol.6, p.127-143, 1978. (See annotation in Section II.)

Gross, M.G. Estuarine Cleanup -- Can It Work? In: Estuarine Processes. Volume I: Uses, Stresses, and Adaptation to the Estuary; Edited by Martin Wiley; Academic Press, New York, San Francisco, London, 1976, p.3-14.

Available data show no evidence of major improvement in estuarine water quality in the United States in recent years. Dissolved oxygen (DO) concentrations in New York Harbor have improved only slightly despite decades of building new treatment facilities and upgrading older plants. No improvement in DO levels has yet been documented for the Upper Delaware Estuary. But increased DO values in the Thames Estuary following construction and enlargement of major sewage treatment facilities indicate that estuarine water quality can be improved. Areas in the Thames previously devoid of DO in summer have DO values averaging about 30 percent of saturation. Odor problems have been alleviated and fish now are caught in the estuary. Successful cleanup of the Thames Estuary required well defined objectives and a regional plan based on a comprehensive scientific study. Capital expenditures exceeded 500 million (1974) dollars, about half of that since 1950. At least 15 years were required to achieve the cleanup objectives, including delays caused by World War II; planning and implementation required several decades. References (25 items).

Gross, M.G. Sediment and Waste Deposition in New York Harbor. Hudson River Colloquium. Annals of the New York Academy of Sciences, vol.250, p.112-128, May 24, 1974. (See annotation in Section II.)

Gross, S.P. Pollution Abatement Programs in the Delaware River Estuary. Paper presented at the American Institute of Chemical Engineers Water Symposium Series, vol.69, p.414-421, 1972.

The program of the Delaware River Basin Commission to abate pollution in the Delaware River Estuary begun in 1968, which was undertaken to implement water quality standards adopted by the Commission in 1967, is the first to utilize the concept of allocation of stream assimilative capacity. Although abatement measures for most of the nearly 100 waste sources are either in the construction or planning steps, some abatement of waste discharges has occurred, and some minor improvements in stream quality have been observed. The significant features of the program are described, as well as initial, current, and projected waste discharge characteristics and stream quality conditions. Literature Cited (11 items).

Gustafson, J.F. Estuarine Pollution -- Reality or Fantasy. WORLD DREDGING & MARINE CONSTRUCTION, vol.11, No.12, p.38-40, November 1975.

The author presents evidence indicating that estuarine sediments laid down thousands of years ago would not pass our

present Environmental Protection Agency (EPA) standards for determining acceptable levels of pollution for dredging and dredged material disposal. He contends that regulatory agencies must recognize and accept that estuaries today are doing what they always have done. Therefore, we cannot set levels of so-called modern pollution that could not be met by sediment thousands of years of age. The need is indicated for a realistic method of determining the actual levels of chemicals absorbed to clays or other sediments without also dissolving the sediment and of separating the problems of organic pollution from those of natural erosion and sedimentation. Bibliography (7 items).

Hahn, H.H., and Klute, R. Pollutional Effects of Suspended Sedimented and Eroded Particulate Material in the Aqueous Environment. Proceedings of the International Conference on Environmental Sensing and Assessment, Las Vegas, Nevada, September 14-19, 1975, vol.I.

Sediments and corresponding loads of suspended material in an aquatic system reflect hydrochemical and ecological conditions and their change over a long time period. There is evidence that monitoring of the dissolved phase alone does not allow a definite description of any aqueous environment. There is a direct pollutional effect from suspended or sedimented fine particles as demonstrated, for instance, by changes in biological activity in the river Neckar or by increased difficulties for various water users. In addition there are indirect pollutional effects through various reactions of dissolved polluting substances with the solid phase as exemplified by the fate of heavy metals. The most important processes responsible for transport and distribution of particulate material are aggregation, sedimentation, erosion as well as aggregate destruction. The extent and relative effect of these processes depend upon hydrodynamic factors on one hand and physicochemical factors on the other. Dissolved substances through their association with the solid phase, mainly due to adsorptive mechanism, are affected by similar processes as the enrichment of heavy metals in the river Neckar shows. There are first attempts to describe pollutional effects of particulate material and associated dissolved substances. A simple mass-balance as well as a more complicated dynamic model for the distribution of suspended solids and heavy metals, as applied to the river Neckar, show the usefulness and range of applicability of such modelling. From these considerations it is concluded that present monitoring of the suspended solid phase alone is insufficient. If data and knowledge existing on the suspended material are to be used in a meaningful way additional information has to be gathered. References (25 items).

Hann, R.W., Jr., and Young, P.J. Mathematical Models of Water Quality Parameters for Rivers and Estuaries. Texas A&M University, Water Resources Institute, Technical Report No.45, October 1972. (See annotation in Section VI.)

Harden, T.O., and Shen, H.T. Numerical Simulation of Mixing in Natural Rivers. Journal of the Hydraulics Division, ASCE, vol.105, No.HY4, p.393-408, April 1979.

A numerical model is developed for two-dimensional transient mixing in natural river channels. Through the use of an orthogonal curvilinear coordinate system based on the geometry and the flow distribution of the river channel, the physical domain is mapped into a rectangular strip by introducing the cumulative discharge as the new transverse coordinate. The concentration values at each point in the grid system are then determined at time levels by using a combined implicit/explicit finite difference successive scheme. A computer program is developed to solve these equations, and a case study is presented and verified with an existing steady-state analytical solution and field measurement. References (25 items).

Higuchi, H. and Yanagi, T. Horizontal Diffusion in a Tidal Model. Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, Copenhagen, Denmark, vol.III, 1975, Chapter 139 (p.2377-2390). (See annotation in Section VI.)

Higuchi, H., Fukuda, T., Ihara, H., et al. Experimental Studies of Tidal Flow and Diffusion in the Seto Inland Sea. Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, Copenhagen, Denmark, vol.III, 1975, Chapter 138 (p.2368-2376). (See annotation in Section VI.)

Hinwood, J.B., and Wallis, I.G. Classification of Models of Tidal Waters. Journal of the Hydraulics Division, Proc. ASCE, vol.101, No.HY10, p.1315-1331, October 1975. Discussion, vol.102, No.HY6, p.808-811, June 1976; Closure, vol.102, No. HY12, p.1776-1777, December 1976. (See annotation in Section VI.)

Hinwood, J.B., and Wallis, I.G. Modelling the Movement of Conservative Materials in Tidal Estuaries. First Australian Conference on Coastal Engineering, Sydney, May 14-17, 1973; Engineering Dynamics of the Coastal Zone, p.159-166. (See annotation in Section VI.)

Holly, F.M., Jr., and Preissmann, A. Accurate Calculation of Transport in Two Dimensions. Journal of the Hydraulics Division, Proc. ASCE, vol.103, No. HY11, p.1259-1277, November 1977. (See annotation in Section I.)

Horiguchi, T. Numerical Analysis of Waste Water Dispersion in Thermally-Stratified Layers. COASTAL ENGINEERING IN JAPAN, vol.16, p.187-200, 1973.

In this paper, the formation process of two stratified layers due to the waste discharge of high temperature and small density is treated in a channel which has a tidal motion, and moreover, the dispersion of waste material in the upper layer is investigated, provided that the change of density is not affected by the pollutant but depends only on the water temperature. The solutions of these problems are pursued by numerical analyses. References (4 items).

Howells, W.R., Owens, M., and Stoner, J.H. Water Quality Aspects of Welsh Estuarine and Coastal Waters. JOURNAL OF THE INSTITUTION OF WATER ENGINEERS AND SCIENTISTS, vol.32, No.5, p.365-390, September 1978. (See annotation in Section V.)

Jackson, H.W. Estuary Studies (161.3) (Training Manual). U.S. Environmental Protection Agency, Cincinnati, Ohio, September 1972.

The report includes a collection of expanded basic outlines that deal with the estuarine environment to be used for course studies. These include: Origin and hydrology of estuaries; Geological studies; Chemical dynamics of estuaries; Estuarine biology; and Estuarine pollution.

James, A. Pollution of the River Tyne Estuary -- The Use of Mathematical Models. WATER POLLUTION CONTROL, vol.75, No.3, p.322-340, 1976. (See annotation in Section VI.)

Jeane, G.S., II, and Pine, R.E. Environmental Effects of Dredging and Spoil Disposal. WATER POLLUTION CONTROL, vol.47, No.3, p.553-561, March 1975. (See annotation in Section V.)

Johanson, P.A., Lorensen, M.W., and Waddell, W.W. A Multi-Parameter Estuary Model. Proceedings of the Conference on Environmental Modeling and Simulation, April 19-22, 1976, Cincinnati, Ohio, p.111-114. U.S. Environmental Protection Agency, EPA 600/9-76-016, July 1976. (See annotation in Section VI.)

Johnson, R.W. A Simulation Model for Studying Effects of Pollution and Freshwater Inflow on Secondary Productivity in an Ecosystem. Ph.D. Thesis, Department of Marine Sciences, North Carolina State University at Raleigh, 1974. (See annotation in Section VI.)

Jordan, R.A. Observations on Dissolved Oxygen Conditions in Three Virginia Estuaries After Tropical Storm Agnes (Summer 1972). In The Chesapeake Research Consortium, Inc., The Effects of Tropical Storm Agnes on the Chesapeake Bay Estuarine System, CRC Publication No. 54, November 1976, p.348-367.

Dissolved oxygen (DO) and salinity levels in the James, York, and Rappahannock estuaries were monitored for approximately two months (June 24-August 31, 1972) following Tropical Storm Agnes. DO depressions developed more rapidly and were more severe in the deep waters of the York and Rappahannock than in the James. Depressions that developed immediately after the storm were followed by recoveries and subsequent, more severe depressions. In late July, bottom water DO concentrations below 1 mg/l were found at stations covering 15 miles of the York and 25 miles of the Rappahannock. Comparison of river data with Chesapeake Bay data suggests that the rivers contributed oxygen poor water to the Bay during the post-Agnes period. Comparison of 1972 river data with data from other years suggests that the post-Agnes oxygen depressions were more severe than those that occur in normal years. Literature Cited (1 item).

Josefesson, B., and Nyquist, G. Fluorescence Tracing of the Flow and Dispersion of Sulfite Wastes in a Fjord System. AMBIO, vol.5, No.4, p.183-187, 1976.

A fluorometric method was used to determine lignin sulfonates and to trace the dispersion and flow of sulfite wastewater in Idefjord, Norway, and its vicinity. The effect of pollution from the paper and pulp mills in Halden, Norway, was

estimated. An influence of lignin wastewater from north of the study area was also recorded, but lack of measurements north of the study area made it impossible to gain a total representation of the hydrographical situation outside Idefjord (12 graphs, 13 references, 1 table).

Karpuzcu, M. Pollution Problem of the Golden Horn. MARINE POLLUTION BULLETIN, vol.5, No.2, p.27-31, February 1974.

The Golden Horn is an estuary which lies in a valley between Old Istanbul and Pera, and receives water from the Alibey and Kagithane creeks. The Golden Horn was once a recreation area and supported a fishery; now it is an open sewer. It receives untreated domestic sewage from a population of 600,000 and large volumes of industrial waste. Sources of pollution, estuary circulation, siltation and filling problems, and biological and bacteriological conditions in the estuary are described. Projects for water supply and waste water disposal of the Greater Istanbul area are underway, and 2 large channels will be built on both sides of the Golden Horn to collect all the waste water and industrial waste and carry it to the Sea of Marmara. A connection of the Kagithane valley tributary end of the Golden Horn estuary to the Black Sea is a future possible solution.

Keen, K. A Survey of Dispersion Coefficients for Estimating Pollutant Transport. Grumman Aerospace Corporation, Grumman Research Department Memorandum RM-562, December 1972.

Originally submitted to C.W. Post College in May 1971 as a partial requirement for a M. S. degree in Marine Science. The fate of pollutants discharged into any body of water represents one of today's most pressing problems. Once discharged, these pollutants are distributed primarily by advection and turbulent diffusion. To estimate the magnitude of this latter mechanism, a determination of the turbulent dispersion coefficient is necessary. A survey is presented of recent attempts to define this coefficient for coastal regions, rivers, and estuaries. References (17 items).

Kennedy, C. Cleaning Up a River. UNDERWATER NATURALIST, vol.7, No.4, p.4-12, November 1972.

Results of a study to determine the amount of pollution in Navesink River in Monmouth County, New Jersey, are presented. Samples were analyzed for phosphate-P, nitrite-N, Fe, DO, temperature, salinity, conductivity, and types of planktonic organisms. Information on the location and natural history of the river is provided. The history of population growth in the area surrounding the river and the resulting increase in sewage disposal into the river are discussed.

Ketchum, B.H. Population, Resources, and Pollution and Their Impact on the Hudson Estuary. Hudson River Colloquium. Annals of the New York Academy of Sciences, vol.250, p.144-156, May 24, 1974. This paper presents results of a preliminary survey of pollution in the estuary and indicates procedures necessary to restore the estuary to normal useful condition. References (13 items).

Kim, H.H., and Hickman, G.D. An Airborne Laser Fluorosensor for the Detection of Oil on Water. Second Joint Conference on Sensing of Environmental Pollutants, Washington, D.C., December 10-12, 1973, p.369-371. (See annotation in Section VII.)

Klemas, V. Remote Sensing of Coastal Pollutants. Delaware University, College of Marine Studies, 1978. National Aeronautics and Space Administration, CR-157586. (See annotation in Section VII.)

Klemas, V. Remote Sensing of Coastal Wetland Vegetation and Estuarine Water Properties. Estuarine Processes; Volume II, Circulation, Sediments, and Transfer of Material in the Estuary, edited by Martin Wiley. New York, Academic Press, 1977, p.381-403. (See annotation in Section VII.)

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Int-grated Satellite-Aircraft-Drogue Approach. Proceedings of the International Conference on Environmental Sensing and Assessment, Las Vegas, Nevada, September 14-19, 1975, vol.I. (See annotation in Section VII.)

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Kramer, G.R. Predicting Reaeration Coefficients for Polluted Estuary. Journal of the Environmental Engineering Division, Proc. ASCE, vol.100, No.EE1, p.77-92, February 1974. (See annotation in Section I.)

Kuo, A.Y. A Model of Tidal Flushing for Small Coastal Basins. Proceedings of the Conference on Environmental Modeling and Simulation, April 19-22, 1976, p.543-547. U. S. Environmental Protection Agency, EPA 600/9-76-016, July 1976. (See annotation in Section VI.)

Kuo, C.Y. Effects of Salinity on Turbulent Diffusion of Pollutants. Water Resources Research Institute, Research Center, University of Puerto Rico, Mayaguez, UPRICO-WRRI-PR-73-74, December 1973.

Due to the spatial variation of salinity in estuaries and coastal waters, a study was made in the laboratory of the molecular and the turbulent diffusion process in the fluid media with various salinity. Dye diffusions were performed in salt water of known concentrations to simulate the dispersion of pollutant in tidal waters. Both the turbulent and the molecular diffusion coefficient increase as the salinity increases. The variation of the turbulent diffusion coefficient is approximately linear with respect to the salinity. However, the molecular diffusion coefficient tends to change nonlinearly with the salinity. The turbulent diffusion rate is rather uniform with comparison to the molecular diffusion rate. References (3 items).

Laevastu, T., Clancy, M. and Stroud, A. Computation of Tides, Currents and Dispersal of Pollutants in Lower Bay and Approaches to New York with Fine Medium Grid Size Hydrodynamical-Numerical Models. Part 3. Environmental Prediction Research Facility (Navy), Monterey, California, Technical Note No.3-74, January 1974. (See annotation in Section VI.)

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Leendertse, J.J., and Liu, S.-K. A Water-Quality Simulation Model for Well Mixed Estuaries and Coastal Seas: Volume VI, Simulation, Observation, and State Estimation. The New York City Rand Institute, R-1586-NYC, September 1974. (See annotation in Section VI.)

Leendertse, J.J., and Liu, S.-K. A Water-Quality Simulation Model for Well Mixed Estuaries and Coastal Seas: Volume VII, A Hindcast. Rand Institute, New York City, R-1774-NYC, July 1975.

This report describes a hindcast of post-rainstorm coliform bacteria distributions in Jamaica Bay made by use of a water-qual ty simulation model of that bay and models of the surrounding drainage basins on the basis of tide, wind, and rainfall

data. That hindcast is then compared with coliform estimates obtained by field sampling. Although the investigators did not have access to the results of the field sampling until the hindcast was completed, the estimates obtained by simulation agree well with the estimates from field data. It is concluded that the models used here are capable of making predictions for engineering assessments. References (10 items).

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This report presents an assessment of the impact on water quality of a hurricane barrier across Rockaway Inlet, Jamaica Bay, New York. A Numerical water-quality simulation model was used to simulate present conditions and conditions with the barrier plans. The main criteria used for assessing changes in water quality were the net circulation in the bay, distributions of coliform bacteria, and distribution of chlorides, and dissolved oxygen. Some results of the study were: (a) The proposed hurricane barrier plans cause slight phase retardation in the tidal propagation in the Jamaica Bay system, (b) the proposed barrier plans create no significant change in the transient (short-term) dispersion and transport of pollutants such as coliform bacteria discharged in the bay, and (c) the construction of the barrier will induce only insignificant changes in the chloride concentration and distributions. References (8 items).

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Lehmann, E.J., Editor. Thermal Pollution. Part 3. Hydrology and Hydrodynamics (A Bibliography with Abstracts). Search Period Covered 1964 - March 1976. National Technical Information Service, Springfield, Va., March 1976. NTIS/PS-76/0130 (Supersedes NTIS/PS-75/220).

All aspects of the hydrology and hydrodynamics of heated effluents are covered in this bibliography of Federally-funded research, including mixing, diffusion, modeling, heat transfer, and flow. (This updated bibliography contains 177 abstracts, 53 of which are new entries to the previous edition.)

Lepetit, J.-P., Cazenave, M., and Davesne, M. Complementarité des modèles physique et mathématique pour l'étude de l'échauffement d'un estuaire sur un site de centrale électrique. Proceedings, XVIth Congress of the International Association for Hydraulic Research, São Paulo, Brazil, July 27 to August 1, 1975, vol.3, Paper C22. (In French.) (See annotation in Section VI.)

Love, P. Estuary & Foreshore Planning in Christchurch. SOIL & WATER, vol.14, No.5, p.18-19, October 1978. (See annotation in Section V.)

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Martin, J.M., Meybeck, M., Salvadori, F., et al. Pollution chimique des estuaires: etat actuel des connaissances; revue bibliographique arrêtée en juin 1974 (Chemical Pollution of Estuaries: Present State of Knowledge; Bibliographic Review Ending June 1974). Publications du Centre National pour l'Exploitation des Oceans (CNEXO) Serie: Rapports scientifiques et techniques No.22, 1976. (In French.)

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The optimal waste loading in order to meet a specified water quality goal is

found for a class of estuaries exhibiting zero freshwater flow. The distributed parameter models of the estuary are derived and the response of DO deficit to a discharge of waste material is expressed in the form of integral operators, where the kernels are Green's functions. Using functional techniques a minimization problem is formulated and the condition for a minimum in the form of a Fredholm equation is presented. Since the problem formulation includes transient effects, a water quality goal which is a function of distance as well as time can be handled easily. Also, because the discharge function is distributed over distance, attainment of the water quality goal is maximized. This is in contrast to existing discharge configurations, consisting of scattered point discharges, where the goal can be met without violation only in segments of the estuary. In addition, the representation of the response of DO deficit by integral operators allows the DO deficit profile to be computed readily for any waste loading, including, the optimal discharge. References (14 items).

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May, E.B. Environmental Effects of Hydraulic Dredging in Estuaries. ALABAMA MARINE RESOURCES BULLETIN, No.9, p.1-85, April 1973. (See annotation in Section V.)

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McDowell, D.M., and O'Connor, B.A. Hydraulic Behaviour of Estuaries. John Wiley, New York, 1977. (See annotation in Section I.)

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Merefield, J.R. Barium Build-Up in the Teign Estuary. MARINE POLLUTION BULLETIN, vol.7, No.11, p.214-216.

Accumulations of barium occur in the River Teign, in south-west England, and its estuary, largely in the form of barytes. These concentrations are derived from weathering in the Teign Valley orefield, an area of mineralization scattered with mine dumps. It appears that although barium values may increase in the upper confines of the estuary the net effect on lower reaches will be negligible. Bibliography (9 items).

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Mills, B.C. Coast Guard Airborne Remote Sensing System. Second Joint Conference on Sensing of Environmental Pollutants, Washington, D.C., December 10-12, 1973, p.363-367. (See annotation in Section VII.)

Mohr, A.W. Energy and Pollution Concerns in Dredging. Journal of the Waterways, Harbors and Coastal Engineering Division, Proc. ASCE, vol.101, No.WW4, p.405-417, November 1975. (See annotation in Section V.)

Moulder, D.S., and Varley, A. A Bibliography on Marine and Estuarine Oil Pollution. The Laboratory of the Marine Biological Association of the United Kingdom, Citadel Hill, Plymouth, Devon. September 1971.

This bibliography contains references to almost 1100 papers on marine and estuarine oil pollution published over the past 100 years. Papers on the effects of oil pollution on sea birds have not been included.

Moulder, D.S., and Varley, A. A Bibliography on Marine and Estuarine Oil Pollution; Supplement 1. Marine Pollution Information Centre, Marine Biological Association of the United Kingdom, Citadel Hill, Plymouth, Devon, June 1975.

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legal, economic and social aspects and on pollution schemes, have been excluded.

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Munday, J.C., Jr., Byrne, R.J., Welch, C.S., et al. Applications of Remote Sensing to Estuarine Problems. Annual Report No.3. Virginia Institute of Marine Science, December 1975. (See annotation in Section VII.)

Munday, J.C., Jr., Gordon, H.H., Welch, C.S., et al. Applications of Remote Sensing to Estuarine Management. Annual Report No.4. Virginia Institute of Marine Science, July 1976. (See annotation in Section VII.)

Murfee, G.W., Fruh, E.G., and Masch, F.D., Jr. Establishment of Operational Guidelines for Texas Coastal Zone Management: Interim Report on Estuarine Modeling. University of Texas at Austin, May 1973. (See annotation in Section VI.)

National Research Council, Geophysics of Estuaries Panel. Estuaries, Geophysics, and the Environment. National Academy of Sciences, Washington, D.C., 1977.

Contents: Longitudinal Circulation and Mixing Relations in Estuaries, by Charles B. Officer. Lateral Circulation Effects in Estuaries, by Keith R. Dyer. River Plumes and Estuary Fronts, by Richard W. Garvine. Fjord and Salt-Wedge Circulation, by Maurice Rattray, Jr. Turbulent Processes in Estuaries, by Kenneth F. Bowden. The Coastal Boundary Layer, by Gabriel T. Csanady. Water-Quality Analyses of Estuarine Systems, by Donald J. O'Connor, Robert V. Thomann, and Dominic M. Di Toro. Real-Time Models for Salinity and Water-Quality Analysis in Estuaries, by Donald R. F. Harleman. Nutrient and Particulate Matter Budgets in Urban Estuaries, by H. James Simpson, Susan C. Williams, Curtis R. Olsen, and Douglas E. Hammond. Suspended Sediment Transport and the Turbidity Maximum, by Ronald J. Gibbs. The Physical Characteristics and Environmental Significance of Fine-Sediment Suspensions in Estuaries, by Robert R. Kirby and W. R. Parker. The Fate of Metals in Estuaries, by Karl K. Turekian. Bibliographies.

Nece, R.E., and Knoll, C.R. Flushing and Water Quality Characteristics of Small-Boat Marinas. Charles W. Harris Hydraulics Laboratory, University of Washington, Seattle, Technical Report No.40, June 1974.

Tide induced circulation patterns and gross flushing characteristics of two small-boat marinas are compared with field observations of currents and water quality within the marinas. Both marinas had comparable geometries, gross flushing characteristics, and water quality. There was not sufficient difference between the two marinas studied to verify how well small-scale hydraulic models may be used as predictors of overall quality within a particular marina. Water quality parameters sampled and reported for the period June-September, 1973, are temperature, dissolved oxygen, nitrate, pH, and chlorophyll a, the latter used as an index of total biomass in the water column. Comparable data were taken at a lake marina, for comparison between salt and fresh water environments. A sampling procedure is suggested for obtaining standardized descriptions of the quality of water within a marina as compared to the quality of ambient waters. The suggested approach is conservative, being based on maximum detention times of water within the marina, and incorporates sampling at that time on the tidal cycle when spatial variations in local exchange and water quality within the marina basin are minimum. Bibliography (22 items).

Nece, R. E., Welch, E.B., and Reed, J.R. Flushing Criteria for Salt Water Marinas. Charles W. Harris Hydraulics Laboratory, University of Washington, Seattle, Technical Report No.42, June 1975.

Water quality problems, such as noticeable densities of plankton algae and subsequent reduction in dissolved oxygen content, were observed in only one of four studied marinas. A plankton algal bloom reached at least 25 µg/ℓ chl a in one section of Lagoon Point Marina and was followed by dissolved oxygen content as low as 2 mg/ℓ. This occurred in one section of the poorly flushed, closed end of the marina. From these observations, and an assumed maximum plankton growth rate of 100% per day, NO_3-N as the limiting nutrient and 50% of surface intensity as optimum for light, the expected maximum steady state plankton biomass was estimated for varying mixing depths (mean depth of marina) and dilution rates. The observed plankton biomass was very close to what would be expected from a marina like Lagoon Point that has a 2.5 m mean depth and dilution rate predicted to be

as low as 10% per day in some sections from a physical scale model. From these findings, criteria are suggested such that to avoid water quality problems of this type the dilution rate should be at least 30% per day and the depth 2 m. If 1 m deeper, dilution could be as low as 10% per day, but increasing depth to avoid problems is probably not as effective as increasing dilution rate because of potentially reduced mixing depths from thermal stratification in poorly flushed deeper situations. Physical scale models are considered to be the most reliable method to determine if dilution rates for a given marina are acceptable, because of the present inadequacy of mathematical models. Bibliography (14 items).

Nelson, J.C., Rauschuber, D.G., and Tischler, L.F. The Effects of Water Resources Development on Estuarine Environments. WATER RESOURCES BULLETIN, vol.9, No.6, p.1249-1257, December 1973.

The Texas Water Development Board has been conducting extensive estuarine data collection activities and associated research to determine the required quantity and quality of freshwater inflows necessary to maintain various environmental conditions and preserve the estuarine ecosystems in Texas. The 1st phase of an extensive estuarine research project is described, consisting of defining the interrelationships between estuarine ecosystems and fresh water and nutrient inflows, and developing and testing quantitative simulation techniques which describe these relationships. Physical and chemical water quality data and biological data on the estuarine ecosystems are being collected, compiled, and analyzed. Hydrodynamic and ecologic simulation models of the estuarine environment are being developed. Literature Cited (5 items).

Neumaier, G., and Silvestro, F. Measurement of Pollution Using Multiband and Color Photography. In New Horizons in Color Aerial Photography; Seminar Proceedings, jointly presented by The American Society of Photogrammetry and The Society of Photographic Scientists and Engineers, June 9-11, 1969, New York City, p.47-58. (See annotation in Section VII.)

Odum, W.E. Potential Effects of Aquaculture on Inshore Coastal Waters. ENVIRONMENTAL CONSERVATION, vol.1, No.3, p.225-230, Autumn 1974.

The kinds of changes that might occur in coastal waters due to the construction and operation of aquaculture facilities are discussed. Some pollutants created by aquaculture operations will include both organic materials and toxic compounds. Construction of facilities can result in sedimentation, changes in the circulation patterns, and interference with freshwater input to the estuary. References (33 items).

Odum, W.E. The Potential of Pollutants to Adversely Affect Aquaculture. Reprinted from Gulf & Caribbean Fisheries Institute, vol.25, p.163-174, 1973.

The purpose of this report is to examine the potential of pollutants to act as limiting factors on aquaculture. Judging from the lack of documented cases, this has not been a serious problem in the past. Apparently, this stems from a negative correlation between industrial development and aquaculture development: Those sections of the world that have seen the greatest industrial advancement have not developed extensively in terms of aquaculture. One of the exceptions to his general pattern is Japan which, significantly, has experienced serious interactions between industrial polluters and culture and inshore fishery operations (e.g., reduced production from pearl oyster rafts anchored in polluted waters and the Minamata Bay disaster). References (38 items).

Officer, C.B. Physical Oceanography of Estuaries. OCEANUS, vol.19, No.5, p.3-9, Fall 1976. (See annotation in Section I.)

Officer, C.B. Physical Oceanography of Estuaries (and Associated Coastal Waters). New York, John Wiley, 1976. (See annotation in Section I.)

Ohlmeyer, F., and Berndt, D. Field and Model Data of Spreading in Estuaries. Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, Copenhagen, Denmark, vol.III, 1975, Chapter 137 (p.2357-2367). (See annotation in Section VI.)

Oil and Estuary Pollution Control: A Quick Look at Some Developments. WATER & WASTE TREATMENT, vol.18, No.7, p.24-28, July 1975.

Oil-water separators, application of the plate separator, automatic separation of oil from waste, oil slick control, absorbents for land and water, and wringing machines and booms are discussed. The 1975 Conference on Prevention and Control

of Oil Pollution is reviewed. A new salvage collection boat designed to combat floating debris, oil, fuel oil, and seaweed is described.

Olufeagba, B.J., Flake, R.H., and Armstrong, N.E. A Boundary Value Approach for Estuarine Water Quality Modelling with Results for Jamaica Bay, New York. ECOLOGICAL MODELLING, vol.1, No.1, p.3-30, May 1975. (See annotation in Section VI.)

Orlob, G.T. Impact of Upstream Storage and Diversions on Salinity Balance in Estuaries. Estuarine Processes; Volume II, Circulation, Sediments, and Transfer of Material in the Estuary, edited by Martin Wiley. New York, Academic Press, 1977, p.3-17.

Impoundment of runoff and its diversion for purposes of power production, flood control, irrigation, or other beneficial uses usually result in significant alteration in the hydrologic regimen of the river system. When diversions are made for in-basin consumptive use or to extra-basin uses, net flows may be reduced to levels not experienced historically. The consequences to water quality, when these diversions occur during periods of low downstream flows, may be such as to impact adversely on the use of water for agriculture. Cases of special interest are the lower San Joaquin Valley and the southern Sacramento-San Joaquin Delta. Since the advent of the Central Valley Project in California in the mid-40's, the quality of inflows to the agriculturally rich southern Delta has progressively declined. Today the area faces a critical shortage of water of adequate quality to sustain agricultural production. Historic changes in salinity balance in the estuarial zone of the Sacramento-San Joaquin Delta are reviewed. Selected examples of upstream flow manipulation are presented to show how the salinity balance of the estuarial system can be most effectively managed. References (1 item).

Ozsoy, E. Flow and Mass Transport in the Vicinity of Tidal Inlets. Coastal and Oceanographic Engineering Laboratory, University of Florida, Gainesville, UFL/COEL/TR-036, 1977. (See annotation in Section I.)

Parker, R.R., and Sibert, J. Effect of Pulpmill Effluent on Dissolved Oxygen in a Stratified Estuary--I. Empirical Observations. WATER RESEARCH, vol.7, No.4, p.503-514, April 1973.

Pulpmill effluent discharged at the surface in Alberni Inlet in British Columbia, Canada, prevents O_2 production in the stratum immediately beneath the halocline by restricting light penetration. This stratum is the source of marine water for entrainment in the halocline and to the upper mixed zone. This situation cannot be remedied by removal of BOD from the pulpmill effluent; rather, the staining properties must be diminished or removed. References (22 items). For Part II see under Sibert, J., in Section IV.

Parsons, T.V., and Fisher, R.A. Experience with Radioisotope Tracing in Local Tidal Waters. WATER POLLUTION CONTROL, vol.76, No.1, p.59-64, 1977. (See annotation in Section VII.)

Patel, B., Mulay, C.D., and Ganguly, A.K. Radioecology of Bombay Harbour -- A Tidal Estuary. ESTUARINE AND COASTAL MARINE SCIENCE, vol.3, No.1, p.13-42, January 1975. (See annotation in Section VIII.)

Paulson, R.W. Estuarine Studies. Earth Resources Aircraft Program Status Review, Volume III - Hydrology, Oceanography, and Sensor Studies, Section 24; Presented at the NASA Manned Spacecraft Center, Houston, Texas, September 16 to 18, 1968. (See annotation in Section VII.)

Pearce, B.R., and Christodoulou, G.C. Application of a Finite Element Dispersion Model for Coastal Waters. Proceedings, XVIth Congress of the International Association for Hydraulic Research, Sao Paulo, Brazil, July 27 to August 1, 1975, vol.1, Paper A4. (See annotation in Section VI.)

Pearson, C.R., and Carter, L. The Application of Simple Models for the Prediction of Effluent Dispersal in Estuaries. EFFLUENT AND WATER TREATMENT JOURNAL, vol.12, No.9, p.472-474, September 1972.

Considers some ways to determine the amount of water available for effective dilution and the amount of dilution the effluent will receive. Discusses sources of information, factors affecting dispersal and dilution of effluents, discharges which clear the estuary in a single tide, and discharges to unstratified estuaries of long retention period. References (2 items).

Percy, K.L., Bella, D.A., Sutterlin, C., et al. Descriptions and Information

Sources for Oregon Estuaries. Oregon State University, Sea Grant College Program, May 1974. (See annotation in Section VIII.)

Phillips, D.J.H. The Use of Biological Indicator Organisms to Monitor Trace Metal Pollution in Marine and Estuarine Environments - A Review. ENVIRONMENTAL POLLUTION, vol.13, No.4, p.281-317, August 1977.

The use of biological indicator organisms to define areas of trace metal pollution appears most attractive, as these organisms not only concentrate metals from water, allowing inexpensive and relatively simple analysis, but they may also represent a moving time-averaged value for the relative biological availability of metals at each site studied. However, the use of indicator organisms introduces biological variables which are not present in physicochemical studies of water sediments. These variables merit consideration inasmuch as they may affect the results of indicator surveys for trace metals. In addition, different indicator organisms measure different portions of the total trace metal load on an ecosystem. The present state of knowedge on the use of indicator organisms to study trace metal pollution is reviewed, with particular reference to the use of macroalgae, bivalve molluscs and teleosts. It is suggested that the macroalgae and bivalve molluscs are the most efficient and reliable indicators developed to the present time. It is further suggested that the effects of sampling and environmental variables have been largely overlooked, and that further study in the field and in the laboratory is necessary before the results of surveys using biological indicator organisms can be relied upon. References, p.310-317.

Physical and Biological Aspects of the Tay Estuary; A Symposium held in the Rooms of the Royal Society of Edinburgh, Edinburgh (Scotland), 5 December 1973. The Royal Society of Edinburgh, Proceedings, Section B, vol.75, Parts 1/2, 1975. (See annotation in Section VIII.)

Pijanowski, B.S. Comparative Evaluation of In-Situ Water Quality Sensors. Second Joint Conference on Sensing of Environmental Pollutants, Washington, D.C., December 10-12, 1973, p.95-107. (See annotation in Section VII.)

Pollock, T.J., and Wallis, I.G. Dispersion and Tidal Flushing in Hann's Inlet. Geophysical Fluid Dynamics Laboratory, Monash University, Clayton, Victoria, Australia, G.F.D.L. Report No.45, Issued November 1971, Re-issued August 1974. (See annotation in Section VIII.)

Pollution Criteria for Estuaries; Proceedings of the Conference held at the University of Southhampton, July 1973; edited by P.R. Helliwell and J. Bossanyi. John Wiley & Sons, New York, 1975.

Partial Contents: The Tidal Hydraulics of the Solent and Its Estuaries, by N.B. Webber. Sedimentary Process Within Estuaries and Tidal Inlets, by E.J. Humby and J.N. Dunn. The Pollution of Ports, by D.R. Houghton. Bacteriological, Biological and Chemical Parameters Employed in the Forth Estuary, by R.W. Covill. Airborne Sensors for Monitoring Pollution, by P.G. Mott. Techniques for Pollution Control in Estuarial Waters, by D.W. Mackay. Factors Affecting Slick Formation at Marine Sewage Outfalls, by J.R. Newton. Planning the Pollution Budget of an Estuary, by R.E. Lewis and R.R. Stephenson. Experiences in Estuary Monitoring, by T.L. Shaw. References and discussions.

Porter, E. Pollution in Four Industrialized Estuaries. HMSO, London, 1973. 98p.

This study is a complement to the Third Report of the standing Royal Commission on Environmental Pollution, "Pollution in some British estuaries and coastal waters." It looks in detail at the estuaries of the Tees, Mersey, Humber and Clyde at the changes in population and industry in the areas bordering the estuaries, and at the effects of these changes upon water quality. In each case the early history of population and industry is reviewed only briefly, and the period of the main study is from 1930 to the present day. 1930 is a reasonable date from which to trace the recent pattern of estuarine pollution, since quite comprehensive surveys of water quality were made in three of the four estuaries in the late 1920's and 1930's and these provide a yardstick by which the results of the most recent surveys can be evaluated. References and bibliography (33 items).

Prater, B.E. The Metal Content and Dispersion Characteristics of Steelworks' Effluents Discharging to the Tees Estuary. WATER POLLUTION CONTROL, vol.74, No.1, p.63-78, 1975.

Paper describes the results of an investigation into this waste water with particular emphasis on (a) its metal content, (b) its dispersion in the estuary, and (c) its possible significant contribution to overall estuarine and marine pollution. References (8 items). With discussion.

Pritchard, D.W. Distribution of Contaminants and Excess Heat in the Bush River and Romney Creek from the Proposed Perryman Electric Power Plant. Chesapeake Bay Institute, The Johns Hopkins University, Special Report 58, Reference 76-13, September 1976.

Report evaluates the effects of the hydrography of the Bush River and Romney Creek on the distribution of contaminants and excess heat which might result from the discharge of cooling tower blowdown water from the proposed generating station. Since the design specifications for the cooling tower, i.e., the source of makeup water and the point of discharge of blowdown water, have not been finalized, four cases are considered covering discharges to the Bush River, Romney Creek and the Bay proper and covering both the Bush River and the Susquehanna River as alternate sources of makeup water. It is shown that in no case does excess temperature appear to have a significant environmental impact. With respect to contaminant dilution, withdrawal of makeup water from the Bush River with blowdown discharge to the Bay clearly exerts the least environmental impact. References (4 items).

Pruter, A.T., and Alverson, D.L., Editors. The Columbia River Estuary and Adjacent Ocean Waters; Bioenvironmental Studies. University of Washington Press, Seattle and London, 1972. 868p.

The thirty-three studies included in this volume, carried out by the University of Washington, Oregon State University, Battelle Memorial Institute, and the National Marine Fisheries Service of the National Oceanic and Atmospheric Administration, describe the physical, chemical, and biological aspects of the Columbia River estuary and adjacent ocean waters, and measure radionuclides in the physical environment and the biota. These studies augment the general body of published information on effects of low-level radioactive wastes introduced into the environment by the nuclear reactors at Hanford, Washington, since they first began producing and extracting plutonium in 1945. In addition to their general bearing on understanding and predicting the fate of radionuclides introduced into the environment, these articles contribute much information on the nature of the fauna, sediments, and ocean processes in the area. They can thus serve as an environmental benchmark against which changes brought about by man's varied activities can be monitored and evaluated.

Prych, E.A., and Haushild, W.L. Water Quality Model of a Salt-Wedge Estuary. Symposium on Modeling Techniques, 2nd Annual Symposium of the Waterways, Harbors and Coastal Engineering Division of ASCE, San Francisco, California, September 3-5, 1975, vol.II, p.1138-1155. (See annotation in Section VI.)

Prych, E.A., Haushild, W.L., and Stoner, J.D. Numerical Model of the Salt-Wedge Reach of the Duwamish River Estuary, King County, Washington. U. S. Geological Survey Professional Paper 990, 1976. (See annotation in Section VI.)

Quentin, B. The Effect of Wind on Currents and Diffusion in Coastal Sea Areas. Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, Copenhagen, Denmark, vol.III, 1975, Chapter 140 (p.2391-2400). (See annotation in Section I.)

Reid, G.K., and Wood, R.D. Ecology of Inland Waters and Estuaries. 2d ed. Van Nostrand, New York, 1976. 485p. (See annotation in Section VIII.)

Rooth, C., and Lee, T.N. A Method for Estimating Thermal Anomaly Areas from Hot Discharges in Estuaries. University of Miami, Sea Grant Program, Sea Grant Special Bulletin No.3, January 1972.

A graphic approach for the prediction of thermal anomaly areas is presented to provide a tool for power plant design considerations. The use of a nomogram is described using the planned discharge of thermal effluent (from Florida Power and Light Corp.) into Biscayne Bay and Card Sound, Florida, as an example. The determination of temperature deviations from ambient, based on energy conservation principles, can be conducted with much greater precision than prediction of absolute temperatures. Input data for the graphic procedure are discharge rate and temperature anomaly. Characteristic ambient temperature and wind conditions also must be specified. References (7 items).

Rudder, C.L., and Reinheimer, C.J. Detection of Water Pollution Sources with Aerial Imaging Sensors. Second Joint Conference on Sensing of Environmental Pollution, Washington, D.C., December 10-12, 1973, p.65-71. (See annotation in Section VII.)

Salas, H.J., and Thomann, R.V. A Steady-State Phytoplankton Model of Chesapeake Bay. JOURNAL, Water Pollution Control Federation, vol.50, No.12, p.2752-2770, December 1978. (See annotation in Section I.)

Schofield, W.R., and Krutchkoff, R.G. Deterministic Model of Dynamic Eutrophic Estuary. Journal of the Environmental Engineering Division, Proc. ASCE, vol.100, No.EE4, p.979-996, August 1974. (See annotation in Section I.)

Schofield, W.R., and Krutchkoff, R.G. Stochastic Model of Dynamic Eutrophic Estuary. Journal of the Environmental Engineering Division, Proc. ASCE, No.EE3, p.613-628, June 1974. (See annotation in Section VI.)

Schrøder, H., Mortenson, P., and Dahl-Madsen, K.I. Mathematical Modelling of Thermal Pollution in an Estuary. Proceedings, XVIth Congress of the International Association for Hydraulic Research, São Paulo, Brazil, July 27 to August 1, 1975, vol.4, Paper D23. (See annotation in Section VI.)

Sedgwick, R., and Arthur, D.R. A Natural Pollution Experiment: The Effects of a Sewage Strike on the Fauna of the Thames Estuary. ENVIRONMENTAL POLLUTION, vol.11, No.2, p.137-160, September 1976.

Arising from the withdrawal of labor by a national union, this case history of acute pollution in the Thames estuary in 1970 illustrates the complexity of interacting parameters, and of recovery from the polluted state. It deals with the chemical changes in the estuary, the effects of weather conditions on the hydrological pattern, concomitant with other physical parameters, and on the quantitative distribution of the estuarine fauna in relation to these variables. The effects of the polluting load on the fauna are then assessed by comparing the changes between it and previous years with that immediately succeeding it. References (17 items).

Segar, D.A. and Cantillo, A.Y. Some Considerations on Monitoring of Trace Metals in Estuaries and Oceans. Proceedings of the International Conference on Environmental Sensing and Assessment, Las Vegas, Nevada, September 14-19, 1975, vol.I.

The trace metal chemistry of the coastal waters of New York and New Jersey in the vicinity of the Hudson-Raritan river discharge has been studied as part of the National Oceanic and Atmospheric Administration (NOAA) Marine Ecosystems Analysis (MESA) New York Bight project. Sampling and analysis procedures which minimize contamination and analysis time were developed for the determination of several dissolved trace metals. The geographical and short term temporal variations of trace metal content appear to be large. However, intensive sampling in a restricted geographical area does reveal the existence of coherent cells of water which contain anomalously high metal concentrations. The geographical location of these cells suggests they are caused by the river discharge influence and by the sewage sludge or dredge spoil dumping. An appreciable fraction of the metal present in the dissolved phase in New York Bight is not determined by historically preferred analytical techniques. The extreme variability of metal concentrations necessitates extensive sampling programs if the processes affecting metal introductions, transport, and removal are to be adequately described. Shipboard instrumentation is under development which will fulfill this requirement by continuous real time horizontal profiling of trace metal concentration from a moving vessel. This equipment may ultimately be modified to perform continuous unattended monitoring from a buoy or platform. References (23 items).

Seklon, K.S., and Binder, R.C. Ultrasonic Techniques to Measure Water Pollutants. Second Joint Conference on Sensing of Environmental Pollutants, Washington, D.C., December 10-12, 1973, p.177-184. (See annotation in Section VII.)

Sherk, J.A., O'Connor, J.M., and Newmann, D.A. Effects of Suspended and Deposited Sediments on Estuarine Environments. In: Estuarine Research, Volume II: Geology and Engineering, edited by L. Eugene Cronin, Academic Press, Inc., New York, 1975, p.541-558. (See annotation in Section II.)

Shindala, A., Zitta, V.L., and Corey, M.W. Water Quality Models for the Pascagoula River Basin; II: Tidal Estuaries. Engineering and Industrial Research Station, Mississippi State University, May 1973. (See annotation in Section VI.)

Sibert, J., and Parker, R.R. Effect of Pulpmill Effluent on Dissolved Oxygen in a Stratified Estuary--II. Numerical Model. WATER RESEARCH, vol.7, No.4, p.515-523, April 1973.

A numerical model is presented which simulates the biological and physical processes of the O_2 supply in a stratified inlet. The introduction of pulpmill effluent into the upper layer of the inlet causes a decrease in the DO concentration of the water due to blockage of photosynthesis in the stratum of water immediately below the halocline. Removal of the BOD from the effluent has very little effect on the O_2 concentration in the upper layer since the supply of O_2 from the lower layer is blocked by the stain. Removal of 90% of the stain from the effluent restores the O_2 concentrations to near normal. References (16 items). For Part I see under Parker, R.R., in Section IV.

Slotta, L.S., Sollitt, C.K., Bella, D.A., et al. Effects of Hopper Dredging and in Channel Spoiling (October 4, 1972) in Coos Bay, Oregon. Oregon State University, Corvallis, July 1973. 147p. (See annotation in Section V.)

Smith, B.N. The Role of Sea Grasses and Benthic Algae in the Geochemistry of Trace Metals in Texas Estuaries. Texas University, Department of Botany, October 1974. (See annotation in Section II.)

Smith, R. Coriolis, Curvature and Buoyancy Effects upon Dispersion in a Narrow Channel. Hydrodynamics of Estuaries and Fjords; Proceedings of the 9th Liege Colloquium on Ocean Hydrodynamics, 1977, p.217-232.

The work of Smith (1976) concerning buoyant contaminants in shallow channels is extended to include allowance for curvature of the channel and for the earth's rotation. For weak buoyancy the Coriolis and centrifugal effects lead to a transverse circulation and therefore reduce the longitudinal dispersion relative to that in a straight non-rotating channel. The response of the more dense fluid to these effects is inhibited by the proximity of the channel bed. Thus, it is the less dense fluid that tends to be moved to the outside curve of bends and to the right of the flow direction in the Northern Hemisphere. For stronger buoyancy the transverse density variations reduce or even reverse the circulation and can lead to an increase in the dispersion. Numerical results for the dispersion coefficient are presented for channels of parabolic cross-section. References (17 items).

Smith, S.L. The Role of Zooplankton in the Nitrogen Dynamics of a Shallow Estuary. ESTUARINE AND COASTAL MARINE SCIENCE, vol.7, No.6, p.555-565, December 1978. (See annotation in Section I.)

Snoden, J.O., and Otvos, E.G. Chemical Quality of Surface and Sediment Pore Water in Louisiana and Mississippi Estuaries. Louisiana Water Resources Research Institute, Completion Report B-009-LA, October 1973. (See annotation in Section VIII.)

Sonu, C.J., and Wright, L.D. Mass Transport and Dispersion Off a Tidal Inlet. Seventh Offshore Technology Conference, Houston, Texas, May 5-8, 1975; Proceedings, vol.III, Paper No. OTC 2383. (See annotation in Section I.)

Spalding, D.B. Heat and Mass Transfer in Rivers, Bays, Lakes and Estuaries. Imperial College of Science & Technology, London, Mechanical Engineering Department, Heat Transfer Section, HTS/76/7, April 1976. (See annotation in Section VI.)

Spaulding, M. Numerical Modeling of Pollutant Transport Using a Lagrangian Marker Partical Technique. National Aeronautics and Space Administration, Technical Memorandum NASA TMX-73930, August 1976. (See annotation in Section VI.)

Spaulding, M.L. Two-Dimensional, Laterally-Integrated Estuarine Numerical Water Quality Model. Ph.D. Dissertation, University of Rhode Island, 1972. (See annotation in Section VI.)

Specialty Conference on Dredging and Its Environmental Effects; Proceedings; Mobile, Alabama, January 26-28, 1976. Edited by Peter A. Krenkel, John Harrison and J. Clement Burdick III. New York, American Society of Civil Engineers, 1976. (See annotation in Section V).

Staples, K.D. Estuarine Pollution Control: Objectives and Priorities. The Institution of Civil Engineers, Proceedings, Part 1, vol.60, p.329-343, August 1976. Discussion, Part 1, vol.62, p.283-292, May 1977.

The forms and hydraulic regimes of estuaries are described, together with the nature and effect of the principal polluting elements arising from sewage and industrial waste discharges on developed estuaries. The objectives of pollution control are considered with reference to modeling techniques and the development of engineering proposals for the collection, treatment and discharge of polluting wastes. The costs of engineering works planned for several major British estuaries are compared. The motivation, public attitudes and environmental benefits attached to estuarine pollution control are outlined, with possible priorities for the staged implementation of typical schemes and discussion of the national and regional assessment of priorities for estuarine schemes. References (10 items).

Steele, J.G., Pearce, B.R., Wang, J.D., et al. Finite-Element Modeling of Moreton Bay, Australia. Ralph M. Parsons Laboratory for Water Resources and Hydrodynamics, Department of Civil Engineering, Massachusetts Institute of Technology, Technical Note No.20, July 1977. (See annotation in Section VI.)

Stoertz, G.E., Hemphill, W.R., and Markle, D.A. Airborne Fluorometer Applicable to Marine and Estuarine Studies. Marine Technology Society Journal, vol.3, No.6, p.11-26, November 1969. (See annotation in Section VII.)

Stone, J.H. Louisiana Superport Studies, Report No.2: Preliminary Assessment of the Environmental Impact of a Superport on the Southeastern Coastal Area of Louisiana. Louisiana State University, Department of Marine Sciences, Center for Wetland Resources, No. LSU SG 72 05, Report 2, 1972. (See annotation in Section VII.)

Sullivan, R.H. The Effect of Tidal Currents on Planned Effluent Discharge in Puget Sound. Ocean 75 Record: 1975 IEEE Conference on Engineering in the Ocean Environment, and Eleventh Annual Meeting of the Marine Technology Society, San Diego, California, September 22-25, 1975, p.940-943.

Design construction parameters including location for a proposed sewer outfall off Chambers Creek, Puget Sound, Washington, were developed by the staff of Northwest Consultant Oceanographers, Inc. Applying techniques and computations developed for similar projects, basic working assumptions were developed. These were then tested against a scaled physical model and modified as required. Finally, all assumptions and modifications were evaluated against an on-site field observation project. Currents at various levels were measured by drogues and current meters, one of which was a unique bottom-mounted instrument. Strong current shear at the proposed site assures strong turbulence and mixing. The receiving waters off Chambers Creek are well-able to assimilate both the proposed initial and future effluent loading.

Swartz, R.C. Techniques for Samplying and Analyzing the Marine Macrobenthos. U. S. Environmental Protection Agency, Corvallis Environmental Research Laboratory, EPA-600/3-78-030, March 1978. (See annotation in Section VII.)

Symposium on Direct Tracer Measurement of the Reaeration Capacity of Streams and Estuaries, July 7-8, 1970, Proceedings . . . Georgia Institute of Technology, Atlanta, Ernest C. Tsiviglou, Mark A. McClanahan, and Walter M. Sanders III. Environmental Protection Agency, Water Pollution Control Research Report, Project 16050 FOR, January 1972. (See annotation in Section VII.)

Taylor, D. Natural Distribution of Trace Metals in Sediments from a Coastal Environment, Tor Bay, England. ESTUARINE AND COASTAL MARINE SCIENCE, vol.2, No.4, p.417-424, October 1974. (See annotation in Section VIII.)

Teubner, M.D., and Noye, B.J. Numerical Simulation of Tidal and Thermal Propagation in a Shallow Channel. Fifth Australasian Conference on Hydraulics and Fluid Mechanics, University of Canterbury, Christchurch, New Zealand, 9-13 December 1974; Conference Proceedings, vol.II, p.294-301. (See annotation in Section VI.)

Texas Water Development Board. Techniques for Evaluating the Effects of Water Resources Development on Estuarine Environments. Texas Department of Water Resources, LP-75, 1978. (See annotation in Section VI.)

Thatcher, M.L., Pearson, H.W., and Mayor-Mora, R.E. Application of a Dynamic Network Model to Hydraulic and Water Quality Studies of the St. Lawrence River. Symposium on Modeling Techniques, 2nd Annual Symposium of the Waterways, Harbors and Coastal Engineering Division of ASCE, San Francisco, California, September 3-5, 1975, vol.II, p.1196-1219. (See annotation in Section VI.)

Thomann, R.V., Di Toro, D.M., and O'Connor, D.J. Preliminary Model of Potomac Estuary Phytoplankton. Journal of the Environmental Engineering Division, Proc. ASCE, vol.100, No.EE3, p.699-715, June 1974. (See annotation in Section VI.)

Tischler, L.F., Nelson, J.C., and Burnitt, S.C. The Effects of Water Resources Development on Estuarine Environments. American Water Resources Conference, Eighth, held in St. Louis, Missouri, October 30 - November 2, 1972, Short Papers. American Water Resources Association, Proceedings Series No.16, p.18, 1972. (See annotation in Section VIII.)

Tomczak, M., and Diaz, C.G. A Numerical Model of the Circulation in Cienfuegos Bay, Cuba. ESTUARINE AND COASTAL MARINE SCIENCE, vol.3, No.4, p.391-412, October 1975. (See annotation in Section VI.)

Trites, R.W. Capacity of an Estuary to Accept Pollutants. In: Effects of Elemental Phosphorus on Marine Life; Fisheries Research Board of Canada, Research and Development, Halifax, Nova Scotia, Circular No.2, p.57-69, November 1972.

Concentration of pollutant at any given point in the environment will depend upon rate and concentration of effluent being discharged, decomposition rate of the pollutant, and dilution rate due to mixing with "clean" water. Attention is focused on dilution rate. The rate of flushing will depend upon the strength of tidal and nontidal currents, wind, wave, and swell action, precipitation and fresh water discharge and physical configuration of the area involved. If the response of the water to these forces were understood, the flushing time could be computed in principle and the concentration and distribution of pollutant predicted for any given situation. In practice, a semi-empirical approach must be taken. In many coastal embayments where pollution or potential pollution exists, the circulation and diffusion processes are the result of a number of factors, and frequently no single factor is predominant at all times. Meteorological parameters may frequently be dominant. Experimental tracer techniques, combined with measurements taken over various conditions, appear the most useful approach to the problem. It is probably wise to consider dilution rates at times to be an order of magnitude less than those measured under field conditions. References (8 items).

Tsai, Y.H., and Holley, E.R. Temporal Moments for Longitudinal Dispersion. Journal of the Hydraulics Division, ASCE, vol.104, No.HY12, p.1617-1634, December 1978.

Aris' moment transformation was used to convert the advective-diffusion equation for two-dimensional (longitudinal and transverse) open channel flow into temporal moment equations. The equation for the zeroth temporal moment of the concentration distribution includes the initial concentration distribution which is a Dirac delta function for instantaneous injections. This equation can be solved analytically for some specific velocity distributions but cannot be solved numerically because of the δ function. Using an implicit finite difference scheme, numerical solutions for both spatial and temporal moments were obtained for plane and centered line source initial conditions and for three velocity distributions. The results were used to examine the relationship between the special and temporal moments during both the initial period and the dispersive period. References (19 items).

U. S. Army Engineer District, San Francisco. Dredge Disposal Study, San Francisco Bay and Estuary. Main Report and Appendices A through M. 1974-1977.

The basic concept of the overall study was to address to the greatest extent possible the mechanisms involved and the interrelationships of the various physical, chemical and biological parameters being influenced by the dredging activity or influencing the dredging activities. The concept of baseline type study was not considered to be fully adequate because of the size and complexity of the Bay and the lack of ability to determine cause-effect relationships from baseline changes. Baseline studies were, however, conducted to the extent necessary and other individual elements were conducted in such a way that resulting data would serve as input to baseline descriptions. The study was set up to be problem specific and site specific to San Francisco Bay, recognizing that it may have value to other areas. Thirteen study elements were identified (excluding the studies on

the San Francisco Bar). Each of the thirteen elements addressed aspects of dredging within the Bay using either open water disposal or alternative disposal methods. Bibliographies. Contents: Main Report (February 1977). Appendix A Main Ship Channel (San Francisco Bay) (June 1974). Appendix B Pollutant Distribution (in preparation). Appendix C Water Column (April 1976). Appendix D Biological Community (August 1975). Appendix E Material Release (in preparation). Appendix F Crystalline Matrix (July 1975). Appendix G Physical Impact (July 1975). Appendix H Pollutant Uptake (September 1975). Appendix I Pollutant Availability (October 1975). Appendix J Land Disposal (October 1974). Appendix K Marsh Development (April 1976). Appendix L Ocean Disposal (September 1975). Appendix M Dredging Technology (September 1975).

U. S. Army Engineer Waterways Experiment Station. Heat Dispersion in Physical Estuarine Models; Report 1, State of the Art, by V.L. Zitta and G.W. Douglas. Research Report H-75-2, Report 1, June 1975. (See annotation in Section VI.)

U. S. Army Engineer Waterways Experiment Station. Heat Dispersion in Physical Estuarine Models; Report 2, Experiments in the Delaware River Model, by M.J. Trawle. Research Report H-75-2, Report 2, February 1976. (See annotation in Section VI.)

U. S. Environmental Protection Agency, Office of Water Planning and Standards. Estuarine Pollution Control and Assessment; Proceedings of a Conference, vol.I and II. Washington, D.C., March 1977.

The report is designed to provide information that could be used to establish a national program for the prevention, reduction, and elimination of pollution in estuaries. The individual papers comprising the report address important estuarine problems by presenting state-of-the-art knowledge and experience in the field. Volumes I and II contain the conference papers and Volume III is a microfiche index of Federally funded estuarine research projects.

U. S. Geological Survey. A Numerical Model of Material Transport in Salt-Wedge Estuaries. Geological Survey Professional Paper 917, 1975. (See annotation in Section VI.)

U. S. Office of Water Research and Technology. Estuarine Pollution; A Bibliography. vol.2. Water Resources Scientific Information Center, Report OWRT/WRSIC 76-207, December 1976.

This report, containing 366 abstracts, is another in a series of planned bibliographies in water resources produced from the information base comprising SELECTED WATER RESOURCES ABSTRACTS (SWRA). Volume 2 covers the period from January 1973 to April 1974). Author and subject indexes are included.

U. S. Office of Water Research and Technology. Estuarine Pollution; A Bibliography. vol.3. Water Resources Scientific Information Center, Report OWRT/WRSIC 76-208, December 1976

This report, containing 373 abstracts, is another in a series of planned bibliographies in water resources produced from the information base comprising SELECTED WATER RESOURCES ABSTRACTS (SWRA). Volume 3 covers the period from April 1974 to September 1976. Author and subject indexes are included.

Van Haverbeke, L., and Brown, C.W. Water Pollution Studies Using Raman Spectroscopy. University of Rhode Island, Department of Chemistry, Kingston, 1976.

Methods for adapting laser Raman spectroscopy for monitoring water pollution have been developed and tested. Both conventional and resonance Raman spectra have been measured; the latter effect lowers the detection limits by $\sim 10^3$. In general, Raman spectroscopy has the following advantages in pollution studies: (i) water is a very weak Raman scatterer, (ii) each chemical has a characteristic Raman fingerprint, (iii) quantitative measurements can be made easily, (iv) remote and flow-through detection systems are feasible. These advantages and the difficulties with the method are discussed herein. References (12 items).

Wada, A., and Miyaike, Y. Study on Adaptability of Prediction Method of Simulation Analysis for Diffusion of Discharged Warm Water in the Bay. Civil Engineering Laboratory, Central Research Institute of Electric Power Industry, Technical Report C: 374004, November 1975. (See annotation in Section VI.)

Wakeman, T. Conditions of Pollutants During Dredging and Disposal Operations in San Francisco Bay. Proceedings of a

Workshop on Algae Nutrient Relationships in the San Francisco Bay and Delta, held November 8-10, 1973, at Clear Lake, California, p.195-202. The San Francisco Bay and Estuarine Association, 1975.

One area of man-associated environmental impacts which has recently received considerable attention is the problem of the effects of dredging and disposal operations on the estuarine ecosystem. The San Francisco District of the Corps of Engineers initiated a $3 million study on the effects of dredging and disposal operations on the San Francisco Estuary in April 1972. The study (hereinafter designated as the Dredge Disposal Study) is organized to investigate (a) the effects of the present system of aquatic disposal, (b) alternative disposal methods, (c) condition of the pollutants (biogeochemical), and (d) dredging technology. As shown on the flow diagram, the study elements are intended first to identify the problems associated with dredging and, second, to address the identified problems in terms of alternative disposal methods, dredging equipment, operations and new technology. References Cited (14 items).

Wallis, I.G. Lagrangian Box Models of Waste Transport in Tidal Waters. Australia Institution of Engineers, Civil Engineering Transactions, vol.CE 19, No.1, p.101-109, 1977.

Two Lagrangian water quality models are described. The models are simple and inexpensive to use and simulate the mixing and flushing of wastes in a well-mixed estuary. One model represents the estuary as a series of connected volumes (or boxes) of water which travel up and down the estuary with the tidal water movement. The other model incorporates two layers of boxes travelling up and down the estuary. Since the same volume of water remains within each box, the mixing of waste between adjacent boxes is explicitly modelled. Thus the finite difference equation describing waste mixing in a Lagrangian box model creates very little numerical diffusion and so the effects of waste interaction and decay can also be represented accurately. The two layer model involves a more complicated calculation procedure but provides a more realistic approximation of the dispersion process. The accuracy and stability of the equations used are discussed and the calibration and verification of the models for one harbour are demonstrated. References (11 items)

Wang, J.D., and Connor, J.J. Mathematical Modeling of Near Coastal Circulation. Ralph M. Parsons Laboratory for Water Resources and Hydrodynamics, Report No.200, April 1975. (See annotation in Section VI.)

Wang, S., and Hwang, L.-S. Numerical Simulation of Oil Slick Transport in Bays. Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, Copenhagen, Denmark, vol.III, 1975, Chapter 129 (p.2227-2244). (See annotation in Section VI.)

Wang, S.T., McMillan, A.F., and Chen, B.H. Analytical Model of Dispersion in Tidal Fjords. Journal of the Hydraulics Division, Proc. ASCE, vol.103, No.HY7, p.737-751, July 1977. (See annotation in Section VI.)

Watling, R.J., and Watling, H.R. Trace-Metal Studies in Knysna Estuary. From ENVIRONMENT (Royal Society of South Africa), vol.2, No.10, p.5-7, October 1975.

A part of the general program to monitor marine pollution along the coast of South Africa. Shellfish, in particular oysters, have the ability to accumulate trace metals in their tissues. By analyzing samples of the three species of oysters grown in the Knysna estuary and comparing the results obtained with those reported in the literature for the same and related species, it was determined that trace metal concentrations at Knysna were very low and that there is no major trace-metal source in the estuary. References (6 items).

West, J.R., and Williams, D.J.A. Some Basic Problems of Estuarine Water Quality Control. In Statistical and Mathematical Aspects of Pollution Problems, edited by John W. Pratt; Marcel Dekker, Inc., New York, 1974, Part III, Chapter 13 (p.193-212). (See annotation in Section I.)

Western Canada Hydraulic Laboratories, Ltd., Port Coquitlam, B.C. Final Report - Phase I Studies on Flushing of Small Harbours. Department of the Environment, Small Craft Harbours Branch, Pacific Region, Vancouver, B.C., March 1977. (See annotation in Section VII.)

Whipple, W., Jr., Hunter, J.V., Ahlert, R.C., et al. Estimating Runoff Pollution from Large Urban Areas--The Delaware Estuary. New Brunswick, N.J., Rutgers University, Water Resources Research Institute, July 1978.

Research has been conducted on methods of estimating nonpoint source pollution from large areas, illustrated by the Delaware Estuary. Analyses of the BOD reaction indicate no serious inadequacies, in this case, of the usual approaches based on first order decay estimated from BOD rate determinations. Existing modeling methodologies were analyzed, and suggestions made for improved approaches. Subsequent quantitative analysis was made on the basis of storm event loading determinations, related statistically to storm characteristics and to land use. Such results can be projected to future conditions, and extended to similar areas elsewhere by land use coefficients. Considerable data, obtained in the Trenton and Philadelphia areas, are compared to experience of other investigators and extended to the urban areas adjacent to the Delaware Estuary. Comparisons are made with estimates made by others for the National Commission on Water Quality, and for Section 208 studies of the Delaware Estuary Region. Although urban runoff loads from cities adjoining the estuary are of considerable significance, they are far exceeded by loadings which presumably originate from combined sewers, industrial effluents, and areas upstream in tributary watersheds. For water quality management of large areas, neither a delivery nor a source sampling approach is adequate, because all of the various sources of major pollution loadings are not evaluated by either; and the delivery ratio for various pollutants is not determined by either. A sampling strategy to provide sufficient data for a more complete analysis is outlined. References (41 items).

Whipple, W., Jr., Hunter, J.V., Dittman, F.W., et al. Oxygen Regeneration of Polluted Rivers: The Delaware River. Environmental Protection Agency, Water Quality Office, Program, No.16080 DUP, December 1970.

Tests of surface instream aerators and of bottom diffuser aerators were conducted on the Delaware River near Philadelphia in order to determine the practicability of induced oxygenation of deep navigable rivers. The diffuser was tested at various depths up to 38 feet, but its performance in pounds of oxygen per horsepower hour decreased markedly in the deeper water. Performance of the surface aerator appeared to be somewhat improved over results previously found in a shallower river. Cost estimates and systems analysis led to the conclusion that induced oxygenation by aerators appears to constitute an economical alternative to advanced waste treatment on the Delaware River. This would require structurally reinforced surface aerators in some areas, and bottom diffuser aerators where the surface aerators would interfere with navigation. However, oxygen diffusers developed by others may provide an even more economical means of induced oxygenation for such rivers. References (41 items).

Whipple, W., Jr., Hunter, J.V., Dittman, F.W., et al. Oxygen Regeneration of Polluted Rivers: The Passaic River. Water Resources Research Institute, Rutgers University, New Brunswick, N.J., Water Pollution Control Research Series, 16080 FYA 03/71.

Field tests were made of a mechanical surface aerator and of pure oxygen diffusers in a small polluted river, the upper Passaic. Results generally corroborated results of previous tests, as to performance of surface aerators on such rivers, in excavated pools. A somewhat higher oxygen transfer rate was obtained with a flow concentration device, which, in a permanent installation, would take the form of low rock spur dikes, one extending from each bank, or flow concentration groins. Tests in shallower water, about 7 feet deep, were inconclusive. Tests of oxygen diffusers were fragmentary, due to mechanical difficulties with the equipment; but it was demonstrated that the very fine bubbles used were very largely absorbed in the water. A dye dispersion test gave a very high longitudinal dispersion coefficient downstream of the aerator. Mathematical modeling indicated that during the period of test, parameters of biochemical deoxygenation were not changed by the artificial aeration process. (Whipple-Rutgers.) References (27 items).

White, F.M., Lessmann, R.C., and Spaulding, M.L. Numerical Estuarine Models for Water Quality Management in the Blackstone River-Providence River and the Taunton River-Mt. Hope Bay Complexes. Rhode Island Water Resources Center, Completion Report, OWRR Project A-059-RI, June 30, 1976. (See annotation in Section VI.)

White, S.M., Jirka, G.H., and Harleman, D.R.F. Experimental Investigation of Submerged Condenser Cooling Water Discharge into Casco Bay (William F. Wyman Station). Ralph M. Parsons Laboratory for Water Resources and Hydrodynamics, Department of Civil Engineering, Massachusetts Institute of Technology, Report No.186, July 1974. (See annotation in Section VI.)

Williams, B.J., and Hinwood, J.B. On the Development and Calibration of a Large Numerical Hydrodynamic Model. Fifth Australasian Conference on Hydraulics and Fluid Mechanics, University of Canterbury, Christchurch, New Zealand, 9-13 December 1974; Conference Proceedings, vol.II, p.244-249. (See annotation in Section VI.)

Williams, J.M. Scaling Criteria for Hydraulic Modelling of Thermal Plumes. HRS Notes (Hydraulics Research Station, Great Britain), No.18, p.6-8, May 1976. (See annotation in Section VI.)

Windom, H.L. Unconfined Dumping of Dredge Spoil Said Better than Dike Method. THE WORK BOAT, vol.29, No.10, p.36, 38, 40, 42, October 1972. (See annotation in Section II.)

Windom, H.L. Water-Quality Aspects of Dredging and Dredge-Spoil Disposal in Estuarine Environments. In: Estuarine Research, Volume II: Geology and Engineering, edited by L. Eugene Cronin, Academic Press, Inc., New York, 1975, p.559-571.

The dominant effect that dredging has on estuarine water quality results from chemical exchanges between the water and dispersed sediment. When first dispersed, estuarine sediments release high concentrations of ammonia. This increases microscopic plant production which, in turn, is followed by increases in pH, dissolved oxygen, and BOD. In general, the first effect of dredged sediments being dispersed is that the heavy metals in the water are depleted. In time, however, some metals may be released from the sediment, and their concentration in the water becomes greater than it was to begin with. References (18 items).

Wolanski, E.J., and Banner, M.L. Buoyant Surface Jets in Tidal Longshore Currents. Journal of the Hydraulics Division, Proceedings, ASCE, vol.104, No.HY11, p.1505-1519, November 1978. (See annotation in Section VI.)

Woodward, G.M. Pollution Detection and River Quality Management. WATER TREATMENT AND EXAMINATION, The Journal of the Society for Water Treatment and Examination (Scotland), vol.24, Part 1, p.3-22, 1975.

Aspects of the detection and measurement of pollution in surface waters, groundwater, and estuaries are discussed. Remedial measures for short-term and long-term water quality improvement are proposed, based on practices of the former River Authorities in England and Wales and the existing River Purification Boards in Scotland. References (8 items).

Wrobel, W.E. Thermal Balance in the Hudson Estuary. Hudson River Colloquium. Annals of the New York Academy of Sciences, vol.250, p.157-168, May 24, 1974.

Brief review of aerial infrared survey data and analytical modeling techniques utilized to evaluate the ability of the Hudson estuary to receive future heat inputs from power generation facilities in addition to those from facilities currently in operation, under construction, or planned. References (16 items).

Young, D.R., McDermott, D.J., and Heesen, T.C. Polychlorinated Biphenyls Off Southern California. Proceedings of the International Conference on Environmental Sensing and Assessment, Las Vegas, Nevada, September 14-19, 1975, vol.I.

Polychlorinated biphenyls are ubiquitous contaminants of the marine ecosystem off southern California. The greatest known source is the submarine discharge of municipal wastewaters; aerial fallout also appears to be an important input route. In contrast, surface runoff is only of secondary importance, and direct industrial discharge appears to be completely insignificant. Maximum concentrations of 1254 PCB found in bottom sediments off Palos Verdes Peninsula were 10 ppm, with values falling 100 fold to baseline values over a depth of 20 cm. Muscle tissue from benthic crabs (Cancer anthonyi) and flatfish (Microstomus pacificus) collected from discharge regions also exhibited 100 fold increases in 1254 PCB levels over control values. It appears that the numerous harbors in the Bight also have relatively high levels of PCB contamination. Intertidal bay mussels (Mytilus edulis) contained up to 20 times more 1254 PCB than corresponding specimens collected nearby along the open coast. Finally, an offshore biomonitoring system has been developed, utilizing the intertidal coastal mussel (M. californianus), which appears to offer good potential for indicating zones of greatest biological availability of synthetic pollutants released from submarine outfalls. References (10 items).

SECTION V. REGULATION AND IMPROVEMENT

Examples and histories of prototype improvements, types and locations of improvements, materials and designs of structures, construction practices, dredging, and the practical aspects of regulation and improvement for navigation, sedimentation, contamination, and other purposes, as contrasted to the theoretical aspects.

Agalakov, S.S., Grigoriev, Y.A., Gun'ko, F.G., et al. Laboratory Investigations into the Pattern of Currents in the Neva Estuary in the Gulf of Finland on Completion of Flood Defence Works for Leningrad. Proceedings, XVIth Congress of the International Association for Hydraulic Research, São Paulo, Brazil, July 27 to August 1, 1975, vol.1, Paper A22. (See annotation in Section VI.)

Ages, A.B. A Numerical Model of Victoria Harbour to Predict Tidal Response to Proposed Hydraulic Structures. Environment Canada, Marine Sciences Branch, Pacific Region, Pacific Marine Science Report No.73-3, March 1973. (See annotation in Section VI.)

Allen, G.P., Sauzay, G., Castaing, P., et al. Transport and Deposition of Suspended Sediment in the Gironde Estuary, France. Estuarine Processes; Volume II, Circulation, Sediments, and Transfer of Material in the Estuary, edited by Martin Wiley. New York, Academic Press, 1977, p.63-81. (See annotation in Section II.)

Ball, D.J., and Cox, N.J. Hydrodynamic Drag Force on Groups of Flat Plates. Journal of the Waterway, Port, Coastal and Ocean Division, Proceedings, ASCE, vol.104, No.WW2, p.163-173, May 1978. (See annotation in Section I.)

Barrett, M.J., and Mollowney, B.M. Pollution Problems in Relation to the Thames Barrier. Philosophical Transactions of the Royal Society of London, Mathematical and Physical Sciences, vol.272, No.1221, p.213-221, May 4, 1972. (See annotation in Section VI.)

Barwis, J.H. Annotated Bibliography on the Geologic, Hydraulic, and Engineering Aspects of Tidal Inlets. U. S. Army Corps of Engineers, General Investigation of Tidal Inlets, GITI Report 4, January 1976. (See annotation in Section II.)

Basco, D.R. Feedback from Field Studies of Hydraulic Dredges. Journal of the Waterways, Harbors and Coastal Engineering Division, Proc. ASCE, vol.101, No.WW3, p.277-289, August 1975.

Hydraulic dredging is an extremely complicated process and much is unknown and remains to be discovered about its nature. Soil, operation, and other considerations vary considerably; therefore, actual on-the-job field dredging projects must be employed to gather information and overcome these gaps in dredging knowledge. Methods and equipment are examined for use in overcoming those obstacles that inhibit or eliminate the feedback of information from real dredging situations. References (4 items).

Bates, A.D. Recent Development in Dredging Technology. The DOCK & HARBOUR AUTHORITY, vol.59, No.697, p.237-245, December 1978.

A state of the art review of developments in dredging technology, including the platform dredger Stevin 80 under construction.

Bellis, V., O'Connor, M.P., and Riggs, S.R. Estuarine Shoreline Erosion in the Albermarle-Pamlico Region of North Carolina. North Carolina State University, Raleigh, UNC Sea Grant Publication UNC-SG-75-29, December 1975. (See annotation in Section II.)

Besnier, G., and Leroy, E. L'aménagement des estuaires de la Vilaine et du Lay (Development of the Vilaine and Lay Estuaries). LA HOUILLE BLANCHE, vol.29, No.1/2, p.91-102, 1974. (In French.) (See annotation in Section II.)

Biezeveld, N. Closing a Dam on an Estuary. Transactions, Eleventh International Congress on Large Dams, Madrid, Spain, 11-15 June 1973, vol.II, Question No.41, p.1543-1563, Report 81.

An outline is given of the ways in which beds of estuaries may be protected against scouring during the construction of dams and the methods employed in making the dam closures, with remarks on the development of these methods. Methods discussed: caisson-, gradual-, and multiple closure.

Bonz, P.E. Fabric Boom Concept for Containment and Collection of Floating Oil. U. S. Envrionmental Protections Agency, Environmental Protection Technology Series, EPA-670/2-73-069, September 1973.

The feasibility of applying the concept of oil-water separation by means of woven hydrophilic fabric to a floating oil containment boom was investigated through a series of model tests. A preliminary model boom configuration was developed and towed at speeds to 0.686 m/sec in both calm water and waves. Oil retention performance was superior to that of a conventional flat plate boom of comparable draft in the environment

investigated. A larger model of similar configuration demonstrated no oil leakage when towed at 0.77 m/sec in calm water. While further detailed analysis, engineering, and testing is required to fully examine this concept, it appears that a properly designed flexible boom using a hydrophilic skirt material offers significant potential both as a containment device for floating oil in high current situations and as a high-speed collecting device. References (15 items).

Bowen, A.J., and Pinless, S.J. Effects of Bank Raising Along the Thames. Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, Copenhagen, Denmark, vol.III, 1975, Chapter 145 (p.2471-2482). (See annotation in Section VI.)

Bowen, A.J., and Pinless, S.J. The Response of an Estuary to the Closure of a Mobile Barrier; Richmond Barrier on the Upper Thames Estuary. ESTUARINE AND COASTAL MARINE SCIENCE, vol.5, No.2, p.197-208, March 1977. (See annotation in Section VI.)

Bowman, M.J. Tidal Locks Across the East River: An Engineering Solution to the Rehabilitation of Western Long Island Sound. In: Estuarine Processes. Volume I: Uses, Stresses, and Adaptation to the Estuary; Edited by Martin Wiley; Academic Press, New York, San Francisco, London, 1976, p.28-43. (See annotation in Section IV.)

Brooks, N.H. Dispersion in Hydrologic and Coastal Environments. W.M. Keck Laboratory of Hydraulic and Water Resources, California Institute of Technology, Report No.KH-R-29, December 1972. Same: U. S. Environmental Protection Agency, Pacific Northwest Environmental Research Laboratory, Report EPA 660/3-73-010, August 1973. 136p. (See annotation in Section IV.)

Bruun, P. Stability of Tidal Inlets; Theory and Engineering. New York, Elsevier, 1978. 506p. (See annotation in Section II.)

Carmichael, J.W., and MacInnis, I. Performance Assessment of Self-Dredging Harbour Entrances. Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, vol.II, 1975, Chapter 87 (p.1491-1502).

This provides further information and assessment of three harbor entrance wave traps at Dingwall, Inverness and Plesant Bay located in Canada. These were constructed to reduce the amount of maintenance dredging required in the entrance channels. Wave climate data and littoral material analysis are presented. Observations on the performance of each structure are given and conclusions drawn as to restrictions and constraints on applicability. Reference (1 item).

Cederwall, K., and Svensson, T. Sediment Flushing After Dredging in Tidal Bays. Journal of the Hydraulics Division, Proc. ASCE, vol.102, No.HY7, p.935-953, July 1976. (See annotation in Section VI.)

Chadwick, N.R. The Barmby Tidal Barrage. Journal of the Institution of Water Engineers and Scientists, vol.29, No.7, p.317-335, October 1975.

The Barmby tidal barrage - which comprises two sluice gates and a navigation lock - will have the effect of moving the tidal limit of the river Derwent from Elvington to its mouth, thereby excluding the tide from 24 km of the river. This will permit increased abstraction from the river for public supply. The tidal water which flows into the Derwent river at Barmby, being 60 km from the sea, is not very saline but is very variable in quality. The barrage will exclude the water from the Derwent by closing sluice gates shortly before the tide starts to flow into the Derwent. Investigation of its impacts on the river system, particularly where it concerned land drainage and navigation interests, necessitated the use of mathematical hydraulic modeling of the tidal system. The model has since been used to aid the design of the operating system and a variety of other schemes. These include the design of washland schemes for flood relief and the assessment of the benefits of a tidal surge barrier. References (6 items).

Cook, C.E., Bridge, M.L., Brooks, T.J., III, et al. The Delineation of the Factors Affecting Mississippi Coastal Estuaries and Tidal Marshes. University of Mississippi, Department of Urban and Regional Planning, November 1971. Sea Grant Publication No.MSGP-71-002. (See annotation in Section IV.)

Devenis, K.P. Programs to Improve Water Quality on the Lower Charles. Reprint from Journal of the New England Water Pollution Control Association, vol.7,

No.2, p.183-192, December 1973. (See annotation in Section IV.)

Dixhoorn, J. van. Modern Dredging Techniques. TERRA ET AQUA, No.3/4, p.28-35, 1973. (In English.)

On the first of April 1972 a modern dredging project in The Netherlands was finished. Within about a year, south of the entrance to the Rotterdam Waterway, the new entrance to Europoort was dredged together with the reclamation of a 250 acre beach and dune area north of the Rotterdam Waterway. The project forms part of the new harbor mouth and approach channel for Rotterdam/Europoort at the Hook of Holland.

Dronkers, J.J., and Venis, W.A. Hydraulic and Soil-Mechanical Aspects of Enclosures in Estuaries. Transactions, Eleventh International Congress on Large Dams, Madrid, Spain, 11-15 June 1973, vol.II, Question No.41, p.1421-1438, Report 75.

Partial Contents: General Remarks on the Tidal Studies for the Enclosures. The Hydraulic Studies for the Delta Project in The Netherlands. Choice Between Caisson Closure or Gradual Closure Dependent on Hydraulic and Soil-Mechanical Conditions in the Delta Area. Hydraulic Studies on the Placing of Caissons. Stability of Rubble and Concrete Blocks. Application of Soil Mechanics on Enclosure Methods. Literature (7 items).

Dubach, H.W., Compiler. The North Carolina Coastal Zone and Its Environment; A Compilation of Resource Materials Covering the Coastal Plain, Estuaries, and Offshore Waters. Savannah River Laboratory, Aiken, South Carolina, DP-1423, November 1977. 2 vols. (See annotation in Section II.)

Eddinger, J.M. American Dredging: The Turning Point. MILITARY ENGINEER, vol.70, No.458, p.388-391, November-December 1978.

The American dredging industry is now in the midst of the most important transition in its history. The next few years will determine the health and vitality of the industry for decades to come. By all indications, it is on the verge of unparalleled growth. Years of effort and cooperation between industry--with the National Association of Dredging Contractors at the lead--and the Corps of Engineers have brought about this turning point. The basis for these new opportunities in the private dredging industry is a major shift in the role of the Corps.

Godfrey, P.J., and Godfrey, M.M. Some Estuarine Consequences of Barrier Island Stabilization. In: Estuarine Research, Volume II: Geology and Engineering, edited by L. Eugene Cronin, Academic Press, Inc., New York, 1975, p.485-516.

The purpose of this present preliminary survey was to compare the general condition of intertidal salt marshes behind stabilized barriers in Cape Hatteras National Seashore with that of marshes behind unstabilized sections of the same seashore and behind the islands of Cape Lookout National Seashore. In both sections of the Outer Banks, there are areas of extensive natural dune zones which prevent overtopping or inlet formation; marshes behind these naturally stabilized regions were also sampled. References (18 items).

Gordon, R.B. Dispersion of Dredged Spoil Dumped in Near-Shore Waters. ESTUARINE AND COASTAL MARINE SCIENCE, vol.2, No.4, p.349-358, October 1974. (See annotation in Section II.)

Greenberg, D.A. Mathematical Studies of Tidal Behaviour in the Bay of Fundy. Marine Sciences Directorate, Department of Fisheries and the Environment, Ottawa, Manuscript Report Series No.46, 1977. (See annotation in Section VI.)

Gross, M.G. Effects of Waste Disposal Operations in Estuaries and the Coastal Ocean. In Annual Review of Earth and Planetary Sciences, vol.6, p.127-143, 1978. (See annotation in Section II.)

Gross, M.G. Sediment and Waste Deposition in New York Harbor. Hudson River Colloquium. Annals of the New York Academy of Sciences, vol.250, p.112-128, May 24, 1974. (See annotation in Section II.)

Hall, A. Thames Barrier. From PORT OF LONDON, vol.48, No.572, p.230-231, July 1973. Reprinted from EAST COAST DIGEST.

This paper discusses the problem of flooding in the Thames estuary and its solution by means of the proposed new Thames Barrier.

Halliwell, R., and O'Connor, B. Quantifying Spoil Disposal Practices. Proceedings of the Fourteenth Coastal

Engineering Conference, June 24-28, 1974, Copenhagen, Denmark, vol.III, 1975, Chapter 153 (p.2581-2600). (See annotation in Section II.)

Hard, C.G. Aspects of Dredged Material Research in New England. In: Estuarine Research, Volume II: Geology and Engineering, edited by L. Eugene Cronin, Academic Press, Inc., New York, 1975, p.537-540. (See annotation in Section II.)

Herrmann, F.A., Jr. Movable-Bed Model Study of Galveston Bay Entrance. In: Estuarine Research, Volume II: Geology and Engineering, edited by L. Eugene Cronin, Academic Press, Inc., New York, 1975, p.93-110. (See annotation in Section VI.)

Hoffman, J.F. Decrease in Harbor Maintenance Dredging Through the Use of Pile Dikes and Related Structures Together with an Analysis of Estuarine Sedimentation Problems. U. S. Naval Academy, Energy-Environment Study Group, Report No. USNA-EPRD-29, 30 June 1976.

Most harbors in the continental United States of interest to the U. S. Navy are located within estuaries. Because of the presence of fresh water as well as salt water, special sedimentation problems are created. Eight sources of sediments in an estuary are discussed. Most estuaries are the repository for fine-grained sediments ranging from clay to fine sand in size which would eventually fill the estuary. This report discusses a system to remove sediments by means other than dredging. Part of the system is to entrap estuarine sediment by means of pile dikes to prevent it from entering dredged shipping channels. The pile dike, which consists of two to seven rows of clusters of concrete piles, extends perpendicularly to the river bank. The rows are spaced approximately 5 feet apart; the clusters 15 feet to 20 feet apart. Stringers are placed between each row and secured to pile clusters; and piles are driven about 20 feet to 30 feet below the bottom of the estuary. The second part is to remove periodically the accumulated sedimentary material by a back-flushing and slurry pumping system. The slurry may be pumped to barges, used as landfill, or pumped to off-shore spoil disposal areas such as submarine canyons. Bibliography, p.16-22.

Hosoda, K., Araki, M., and Kimizuka, A. The Tome Estuary Dam. Transactions, Eleventh International Congress on Large Dams, Madrid, Spain, 11-15 June 1973, vol.II, Question No.41, p.501-526, Report 28. (See annotation in Section VI.)

Hovers, G. Maintenance Dredging in Tidal Rivers. TERRA ET AQUA, No.3/4, p.36-41, 1973. (In English.)

Maintenance entails all activities which are permanently required to ensure safety for all shipping traffic in the waterway. Discusses the requirements, causes of recurring soil deposits in the navigation channels of tidal rivers, special circumstances and working conditions, and development tendencies in maintenance dredging in tidal rivers. Emphasis on practice in West Germany.

Hovers, G. Morphological Changes in a Fine Sand Tidal Estuary After Measures of River Improvement. Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, Copenhagen, Denmark, vol.II, 1975, Chapter 74 (p.1274-1288). (See annotation in Section II.)

Howells, W.R., Owens, M., and Stoner, J.H. Water Quality Aspects of Welsh Estuarine and Coastal Waters. JOURNAL OF THE INSTITUTION OF WATER ENGINEERS AND SCIENTISTS, vol.32, No.5, p.365-390, September 1978.

The paper summarizes the Welsh Water Authority's approach to pollution control in tidal waters. The scientific resources, including the establishment of a marine laboratory, to implement this approach are described. Some examples of work carried out and of mathematical modelling exercises are also included. References (28 items).

Ince, S., and Jamieson, W.W. Field and Model Studies for Visakhapatnam Harbor. Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, vol.II, 1975, Chapter 88 (p.1503-1523). (See annotation in Section VI.)

International Association of Dredging Companies. Dredging. The Hague, 1971?

Brief overview of world wide dredging industry.

Jacobs, M.L. Salinity and Sedimentation Study -- Cooper River Rediversion, Charleston, South Carolina. WATER RESOURCES BULLETIN, vol.8, No.1, p.87-92, February 1972. (See annotation in Section III.)

Jeane, G.S., II, and Pine, R.E. Environmental Effects of Dredging and Spoil Disposal. WATER POLLUTION CONTROL, vol.47, No.3, p.553-561, March 1975.

The effects of a dredging project conducted by the Port of Everett, Wash., on the water quality of Everett Harbor and Port Gardner Bay are described. In situ bioassay demonstrates no toxicity. DO is depressed more than 50% in the area of dredging and in the area of supernatant return during sludge material removal. References (2 items).

Kappa, S. How to "Irrigate a Harbor." WORLD DREDGING & MARINE CONSTRUCTION, vol.12, No.9, p.48-50, September 1976.

Severe shoaling in Santa Cruz Harbor prompted USAE's Waterways Experiment Station to design a model for a new harbor. An experimental sand bypassing system, commonly called an eductor system, was installed at Santa Cruz in May 1976. It operates by sucking 150 cu yd/hr from the harbor's channel. The experimental system is a forerunner to a permanent system to be constructed if, at the end of the test period, it is determined that the eductor system can maintain a clear channel and adequately accomplish the required bypassing. The eductor system is expected to reduce the annual maintenance dredging costs, which were nearly $250,000 in 1976. (6 photos.)

Kérisel, T. Aménagement de l'estuaire de la Seine. Approfondissement du chenal d'accès au port de Rouen (Development of the Seine Estuary. Increasing the Depth of the Shipping Channel to the Port of Rouen). LA HOUILLE BLANCHE, vol.29, No.1/2, p.55-66, 1974. (In French.) (See annotation in Section VI.)

Kirby, C.J., Keeley, J.W., and Harrison, J. An Overview of the Technical Aspects of the Corps of Engineers National Dredged Material Research Program. In: Estuarine Research, Volume II: Geology and Engineering, edited by L. Eugene Cronin, Academic Press, Inc., New York, 1975, p.523-535.

The Chief of Engineers was authorized by section 123(i) of Public Law 91-611 to conduct a comprehensive research program related to dredging and the disposal of dredged materials. Phases I and II of the four-phase study identified the various problems associated with dredging and disposal, and developed a comprehensive plan of research to address them. The research effort (Phase III) was approved by the Office of Management and Budget in February 1973 and is being implemented by the Office of Dredged Material Research (ODMR) of the Waterways Experiment Station. The ODMR has the responsibility of program planning, management, and research supervision of a comprehensive study designed to assess the significance and magnitude of the impact dredging and disposal operations have on the environment. Additionally, alternatives that have potential to enhance the environment will be developed, tested, and implemented. References (5 items).

Kniess, H.-G. New Method to Close Tidal Rivers. Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, Copenhagen, Denmark, vol.III, 1975, Chapter 147 (p.2495-2503).

The closing of tidal rivers is still a risky project as the tidal flow alternates periodically its direction, velocity and level. On the last essential section of the Eider dam project a new method for closing tidal rivers was invented and successfully operated. Contrary to common methods the main channel of the river was closed only by hydraulic placement of sand under protection of two permeable pile walls with perforated steel panels.

Knoth, J.S., and Nummedal, D. Longshore Sediment Transport Using Fluorescent Tracer. Coastal Sediments '77, 5th Symposium of the Waterway, Port, Coastal and Ocean Division of ASCE, Charleston, South Carolina, November 2-4, 1977, p.383-398. (See annotation in Section VII.)

Komar, P.D. Relative Quantities of Suspension Versus Bed-Load Transport on Beaches. JOURNAL OF SEDIMENTARY PETROLOGY, vol.48, No.3, p.921-932, September 1978. (See annotation in Section II.)

Leendertse, J.J., and Liu, S.-K. Comparison of Observed Estuarine Tide Data with Hydraulic Model Data by Use of Cross-Spectral Density Functions. The New York City Rand Institute, R-1612-NYC, September 1974. (See annotation in Section VIII.)

Leendertse, J.J., and Liu, S.-K. A Water-Quality Simulation Model for Well Mixed Estuaries and Coastal Seas: vol.VIII, An Engineering Assessment. The New York City Rand Institute, R-1791-NYC, December 1975. (See annotation in Section IV.)

Lespine, E. Aménagement de l'estuaire de la Gironde (Development of the Gironde

Estuary). LA HOUILLE BLANCHE, vol.29, No.1/2, p.71-78, 1974. (In French.) (See annotation in Section VI.)

Love, P. Estuary & Foreshore Planning in Christchurch. SOIL & WATER, vol.14, No.5, p.18-19, October 1978.

Christchurch's Avon-Heathcote Estuary faces several potential threats: urban encroachment, domestic and industrial effluent pollution, nutrient enrichment and euthrophication.

Maquet, J.-F. Aménagement d l'estuaire de la Loire (Development of the Loire Estuary). LA HOUILLE BLANCHE, vol.29, No.1/2, p.79-89, 1974. (In French.)

Historical review of the most important development stages. Dyked, intermediate and downstream sections. Description of the effects of the works on navigation. How the estuary has reacted, and how the various sections form a coherent whole. Examination of the following features and effects: (i) Channel layout, longitudinal section, cross-sections; (ii) Sand drift. Sand accumulation in Nantes harbour; (iii) Suspended sediment drift, the 'mud plug' and 'cream layer'; (iv) Tidal propagation, geometrical loci of high and low tides, flood tide water volumes; (v) Variation of lowest low water level. With discussion.

May, E.B. Environmental Effects of Hydraulic Dredging in Estuaries. ALABAMA MARINE RESOURCES BULLETIN, No.9, p.1-85, April 1973.

Hydraulic channel and shell dredging and open water spoil disposal have little significant immediate effect on water quality in Alabama estuaries. Almost all of the sediment discharged by dredges settles very rapidly and is transported by gravity along the bottom as a separate flocculated density layer and potentially harmful components of the mud are not dissolved into the water. There is a limited, temporary reduction in benthic organisms in areas affected by dredging. Spoil piles from channel dredges can indirectly affect the ecology and usefulness of estuaries by interfering with water circulation and altering salinity. The basic hydrological concepts which determine the effects of dredging should be applicable in other areas. Extensive regulations apparently are not necessary to protect water quality in open water dredging situations but spoil disposal practices from channel dredges must be reconsidered and appropriate new disposal plans developed. Literature Cited (100 items).

McGinnis, C.I. Dredging the Nation's Waterways: A Big Job for Industry and the Army Corps of Engineers. MILITARY ENGINEERS, vol.70, No.458, p.402-404, November-December 1978.

Keeping the nation's waterways open is an important job that requires the best efforts of the dredging industry and the Army Corps of Engineers. Congress and the Administration recognize this need and want private industry to continue handling the bulk of the regular, routine maintenance and new construction dredging. At present, private contract dredges handle about two-thirds of the Corps' annual dredging workload, with Corps dredges doing the rest. Over the past year, private dredges removed 251 million cubic yards of material from federal navigation channels while Corps dredges moved 123 million cubic yards.

Migniot, C1. Etude comparative du taux d'envasement dans différentes zones de l'estuaire de la Loire (Comparative Study of Silting Rates in Various Parts of the Loire Estuary). LA HOUILLE BLANCHE, vol.29, No.1/2, p.137-147, 1974. (In French.) (See annotation in Section II.)

Mohr, A.W. Energy and Pollution Concerns in Dredging. Journal of the Waterways, Harbors and Coastal Engineering Division, Proc. ASCE, vol.101, No.WW4, p.405-417, November 1975.

Energy conservation and pollution control concepts involved in bucket ladder, pipeline, and hopper dredges are discussed. Energy and pollution concerns will change dredging emphasis from traditional economics theory to efficiency in terms of bottom material dredged, moved, and placed and to high effluent density to reduce pollution at the disposal site. Bucket ladder dredge operations inherently require less fuel per unit volume dredged and transported. Bucket ladder dredging also furnishes the bottom material at near in-place density. A revived interest in the mechanical bucket ladder dredge as competitor to the hydraulic pipeline and hopper dredges is anticipated. (3 diagrams, 1 graph, 1 table.)

Nece, R.E., and Lowthian, R.A. Tidal Circulation Study, Proposed Southeast Harbor Development. Charles W. Harris Hydraulics Laboratory, Department of

Civil Engineering, University of Washington, Seattle, Technical Report No.47, January 1976. (See annotation in Section VI.)

Nece, R.E., and Richey, E.P. Application of Physical Tidal Models in Harbor and Marina Design. Symposium on Modeling Techniques, 2nd Annual Symposium of the Waterways, Harbors and Coastal Engineering Division of ASCE, San Francisco, California, September 3-5, 1975, vol.I, p.783-801. (See annotation in Section VI.)

Nerang River Entrance; A Mobile Bed Model. HYDRO DELFT, No.45, p.4-6, December 1976. (See annotation in Section VI.)

Nittrouer, C.A., and Sternberg, R.W. The Fate of a Fine-Grained Dredge Spoils Deposit in a Tidal Channel of Puget Sound, Washington. JOURNAL OF SEDIMENTARY PETROLOGY, vol.45, No.1, p.160-170, March 1975. (See annotation in Section II.)

Ofuji, I., and Ishimatsu, N. Dredge Overflow System Solves Turbidity Problem. WORLD DREDGING & MARINE CONSTRUCTION, vol.11, No.12, p.32-36, November 1975.

An overflow system has been developed in Japan which prevents turbidity, and it is already operating aboard a trailing suction hopper dredge, Tokushun Maru No.1.

Pequegnat, W.E. Meiobenthos Ecosystems as Indicators of the Effects of Dredging. In: Estuarine Research, Volume II: Geology and Engineering, edited by L. Eugene Cronin, Academic Press, Inc., New York, 1975, p.573-583. (See annotation in Section IV.)

Percy, K.L., Bella, D.A., Sutterlin, C., et al. Descriptions and Information Sources for Oregon Estuaries. Oregon State University, Sea Grant College Program, May 1974. (See annotation in Section VIII.)

Protecting Canal Banks Against the Effects of Passing Ships. HYDRO DELFT, No.41, p.2-7. November 1975.

The attack of the banks takes place by waves and currents caused by ships, and sometimes also by other hydraulic phenomena such as tidal motion and wind waves. However, mainly phenomena caused by ships passing are dealt with. Contents: Theoretical backgrounds. Model studies on hydraulic phenomena around ships. Model studies of bank-protection works. Studies on bank-protection works in reality.

Purpura, J.A., Beechley, B.C., Baskette, C.W., et al. Performance of a Jetty-Weir Inlet Improvement Plan. Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, vol.II, 1975, Chapter 86 (p.1470-1490).

Comprehensive monitoring has been carried out since 1970 to determine the performance and effects of a navigation and inlet stabilization project at Ponce de Leon Inlet, Florida. The improvement plan at the tidal inlet included construction of two jetties, a weir sand bypass system, and dredging of a navigable channel. An evaluation was made of the general current patterns, the relative refracted wave energy distribution, and the volumetric beach and hydrographic fluctuations associated with the inlet. An analysis of this data was used to interpret the dramatic and unexpected changes which have resulted along the adjacent coastline and within the inlet after the completion of the inlet improvements. References (8 items).

Read, A.L. Hydraulic Aspects of the West Lakes Development. Civil Engineering Transactions, The Institution of Engineers, Australia, vol.CE15, Nos.1&2, p.11-13, 26, 1973. (See annotation in Section III.)

Renger, E., and Partenscky, H.-W. Stability Criteria for Tidal Basins. Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, Copenhagen, Denmark, vol.II, 1975, Chapter 93 (p.1605-1618). (See annotation in Section II.)

Salem, A.M. Stress-Deformation-Time Behavior of Dredgings. Journal of the Geotechnical Engineering Division, Proc. ASCE, vol.102, No.GT2, p.139-157, February 1976.

Current environmental and economical considerations, or both, frequently dictate that maintenance dredgings from harbors and waterways be placed within diked containment areas located near the point of dredging. Since these dredged materials often contain substantial amounts of clay-like particles, organics, and a variety of industrial and agricultural wastes, the potential usefulness of the associated landfills is strongly affected by the load-deformation-time characteristics of the dredgings. Based on a

synthesis of data obtained from a 4-yr laboratory and field investigation of several landfills, relationships were established between the deformation properties of these materials over the full spectrum of their depositional history and their classification and index properties. The laboratory program consisted of slurry consolidation tests in 8-in. diam chambers, conventional consolidation tests on slurries and tube samples, and the dependent variables that were considered are the coefficient of volume compressibility, compression index, coefficient of secondary compression, and constrained modulus. References (14 items).

Silvester, R. Sediment Transmission Across Entrances by Natural Means. Proceedings, XVIth Congress of the International Association for Hydraulic Research, São Paulo, Brazil, July 27 to August 1, 1975, vol.1, Paper A18. (See annotation in Section II.)

Slotta, L.S., Sollitt, C.K., Bella, D.A., et al. Effects of Hopper Dredging and in Channel Spoiling (October 4, 1972) in Coos Bay, Oregon. Oregon State University, Corvallis, July 1973. 147p.

An integrated study was conducted to gain insight on actual chemical, physical and biological effects associated with the dredging and disposal methods of a hopper dredge. Field investigations and subsequent laboratory analyses were organized to evaluate the nature and magnitude of environmental changes resulting from dredging activities on October 4, 1972 at Coos Bay, Oregon. Methods and evaluation techniques for proper assessment are discussed and post-dredging conditions compared to a pre-dredging baseline. Literature Cited (28 items).

Smith, D.D. Dredging and Spoil Disposal-Major Geologic Processes in San Diego Bay, California. Estuarine Processes; Volume II, Circulation, Sediments, and Transfer of Material in the Estuary, edited by Martin Wiley. New York, Academic Press, 1977, p.150-166.

San Diego Bay is a crescent-shaped, well-mixed estuary 22.5 km long, and initially about 55 km^2 in area, with depths generally less than 4.5 m except for a 7.5-20 m deep channel. The present bay volume is roughly 230 × 10^6 m^3. Since the early 1900's dredging and use of spoil disposal as fill have reworked and shifted 100 to 140 × 10^6 m^3 of sediment, with a resulting 27% reduction in the bay's water area and an approximate doubling in depth of 55% of the original water area. Only 17 to 18% of the original area remains undisturbed by dredging or fill. Since the bay reached its approximate present configuration in Holocene time, the only significant sediment source has been river/stream deposition which delivered an estimated 0.8 to 1.1 × 10^6 m^3 annually, until diversion and damming of principal tributaries between 1875 and 1919 reduced sedimentation by more than 80%. For the 30 year period of maximum dredging (1940-1970), the average dredging rate was 3 to 6 times the original sedimentation rate, and roughly 17 to 34 times the sharply reduced present sedimentation rate. Thus, dredging and spoil disposal as geologic processes are substantially more important than all other erosional and depositional processes presently operating in San Diego Bay. References (40 items)

Sollitt, C.K., and Crane, S.D. Physical Changes in Estuarine Sediments Accompanying Channel Dredging. Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, Copenhagen, Denmark, vol.II, 1975. Chapter 75 (p.1289-1303). (See annotation in Section II.)

Specialty Conference on Dredging and Its Environmental Effects; Proceedings; Mobile, Alabama, January 26-28, 1976. Edited by Peter A. Krenkel, John Harrison and J. Clement Burdick III. New York, American Society of Civil Engineers, 1976.

Partial Contents: Hydraulic Dredges, Including Boosters, by G.G. Gren. Mechanical Dredges, by A.W. Mohr. Analysis of Dredging Projects, by W.B. Pearce. Sand Bypassing with Split-Hull Self-Propelled Barge CURRITUCK, by W.H. Sanderson. Modern Trends in Dredge Design, by T.M. Turner. Ultimate Fate of Suspended Material in Estuaries, by R.B. Krone. Modeling of Coastal Dredged Material Disposal, by S.P. Bowen. Impact of Dredging on Water Quality in Grays Harbor, Washington, by J.M. Smith, J.B. Phipps, E.D. Schermer, and D.F. Samuelson. Response of Carolina Beach Inlet to a Deposition Basin Dredged in the Throat, by A.J. Combe and G.M. Watts. Predicting Material Transportation in Mobile Bay, by G.C. April, Samuel Ng, Hua-An Liu, and D.O. Hill. References.

Stone, J.H. Louisiana Superport Studies, Report No.2: Preliminary Assessment of

the Environmental Impact of a Superport on the Southeastern Coastal Area of Louisiana. Louisiana State University, Department of Marine Sciences, Center for Wetland Resources, No.LSU SG 72 05, Report 2, 1972. (See annotation in Section VII.)

Sündermann, J., Wulzinger, W., and Vollmers, H. The Effect of Dam Constriction on Tidal Processes in an Estuary. Proceedings, XVIth Congress of the International Association for Hydraulic Research, São Paulo, Brazil, July 27 to August 1, 1975, vol.1, Paper A12. (See annotation in Section VI.)

Thames Barrier Will Protect London from Tidal Flooding. ENGINEERING NEWS-RECORD, vol.198, No.14, p.18-19, April 7, 1977.

Brief description of a 1,700-ft barrier with 10 movable steel gates being built across the River Thames which will protect London from infrequent but potentially devastating North Sea tidal flooding.

Thompson, W.W., and Dalrymple, R.A. A History of Indian River Inlet, Delaware. SHORE AND BEACH, vol.44, No.2, p.24-31, July 1976. (See annotation in Section II.)

Tichler, L.F., Nelson, J.C., and Burnitt, S.C. The Effects of Water Resources Development on Estuarine Environments. American Water Resources Conference, Eighth, held in St. Louis, Missouri, October 30 - November 2, 1972, Short Papers. American Water Resources Association, Proceedings Series No.16, p.18, 1972. (See annotation in Section VII.)

Toussaint, R. Le programme de recherches du Centre National pour l'Exploitation des Océans sur l'aménagement du [illegible] (The "Centre National pour l'Exploitation des Océans" Research Program [illegible] ment of the "Coastal Fringe" [illegible] HOUILLE BLANCHE, vol.29, No. [illegible] 106, 1974. (In French)

The main aims of the program [illegible] lows: (1) To acquire better knowledge of the coastal sea environment, present use and future trends, determine the potential [illegible] sites and the limits within which [illegible] can be exploited, [illegible] factors with a view to assisting authorities and communities [illegible] development. The program [illegible]

stress on estuary development. With discussion.

Turner, T.M. Dredging: A Vital but Troubled Industry. MILITARY ENGINEER, vol.70, No.458, p.405-407, November-December 1978.

The dredging industry is troubled but vital to the national defense and economy. It is fraught with problems of inefficiency, education, environment, profitability, and regulation. The industry must address these problems successfully or perish as an economic entity. This alternative is not in the interest of the country and will not occur if the Corps and the dredging industry are successful in combining their efforts to solve mutual problems.

U. S. Army Engineer District, Philadelphia. Long Range Spoil Disposal Study. 7 parts in 8 vols., 1969-1973. (See annotation in Section II.)

U. S. Army Engineer District, San Francisco. Dredge Disposal Study, San Francisco Bay and Estuary. Main Report and Appendices A through M. 1974-1977. (See annotation in Section IV.)

U. S. Army Engineer Waterways Experiment Station. Grays Harbor Estuary, Washington; Report 5, Maintenance Studies of 35-Ft-Deep (MSL) Navigation Channel, Hydraulic Model Investigation, by N.J. Brogdon, Jr. Technical Report H-72-2, Report 5, October 1975. (See annotation in Section VI.)

U. S. Army Engineer Waterways Experiment [illegible] Grays Harbor Estuary, Washington; [illegible] Ft MLW) [illegible] Navigation Channel, [illegible] ment Studies, [illegible] U. S. [illegible]

Miscellaneous Paper H-76-14, June 1976. (See annotation in Section VI.)

U. S. Army Engineer Waterways Experiment Station. Model Studies of Navigation Improvements, Columbia River Estuary; Report 2: Entrance Studies; Section 4: Jetty A Rehabilitation, Jetty B, and Outer Bar Channel Relocation, by F.A. Herrmann, Jr. Technical Report No.2-735, Report 2, Section 4, July 1974. (See annotation in Section VI.)

U. S. Army Engineer Waterways Experiment Station. Navigation Channel Improvements, Barnegat Inlet, New Jersey; Hydraulic Model Investigation, by R.A. Sager and N.W. Hollyfield. Technical Report H-74-1, March 1974. (See annotation in Section VI.)

U. S. Army Engineer Waterways Experiment Station. Neches River Saltwater Barrier, by C.J. Huval. Miscellaneous Paper H-74-9, August 1974. (See annotation in Section III.)

U. S. Army Engineer Waterways Experiment Station. Numerical Analysis of Tidal *Circulation for Long Beach Harbor*, by D.C. Raney. Miscellaneous Paper H-76-4, Report 1, September 1976; Report 2, March 1976; Report 3, September 1976; Report 4, May 1976. (See annotation in Section VI.)

U. S. Army Engineer Waterways Experiment Station. Tillamook Bay Entrance Refraction Study, Tillamook, Oregon, by L.Z. Hales. Miscellaneous Paper H-77-8, August 1977. (See annotation in Section I.)

U. S. Army Engineer Waterways Experiment Station. Tillamook Bay Model Study; Hydraulic Model Investigation, by G.M. Fisackerly. Technical Report H-74-11, November 1974. (See annotation in Section VI.)

U. S. Army Engineer Waterways Experiment Station. Westport Small-Boat Basin Revision Study; Hydraulic Model Investigation, by N.J. Brogdon, Jr. Miscellaneous Paper H-75-8, November 1975. (See annotation in Section VI.)

Vallianos, L. A Recent History of Masonboro Inlet, North Carolina. In: Estuarine Research, Volume II: Geology and Engineering, edited by L. Eugene Cronin, Academic Press, Inc., New York, 1975, p.151-166.

Paper presented at the Second International Estuarine Research Conference, held by the U.S. Estuarine Research Federation at Myrtle Beach, South Carolina, 15-17 October 1973. Masonboro Inlet is located along the southeastern ocean shoreline of North Carolina and, with respect to the general Atlantic coast of the United States, is located at a point approximately equidistant from Boston, Massachusetts, and the southern tip of the Florida peninsula. The morphology of the coastal margin of North Carolina is characterized by three cuspate forelands known as Cape Hatteras, Cape Lookout, and Cape Fear. The ocean shoreline is comprised of a narrow band of low, sandy barrier islands whose widths are generally on the order of 250 meters. These barrier islands are separated by a total of 22 inlets which couple the ocean with the interconnected estuarine waters of the State. Though a barrier island-inlet chain is typical of the entire coastline, there is a marked difference between the northern and southern halves of the State's coastal zone in terms of estuarine areas. In the northern half, the estuaries are expansive bodies of water known as Pamlico Sound and Albemarle Sound. These are the largest embayments on the Atlantic coast contained between a barrier island system and the continental land mass. The southern half of the State's coastal zone is characterized by narrow elongated lagoons comprised of salt marshes and circuitous networks of tidal-flow channels. The width of most of these elongated lagoons does not exceed 1.5 kilometers. The coastal setting at and in the vicinity of Masonboro Inlet embodies the general features of the southern half of the State's coastal zone.

Van de Kreeke, J. Increasing the Mean Current in Coastal Channels. Journal of the Waterways, Harbors and Coastal Engineering Division, Proc. ASCE, vol.102, No.WW2, p.223-234, May 1976. (See annotation in Section I.)

Vittor, B.A. Effects of Channel Dredging on Biota of a Shallow Alabama Estuary. JOURNAL OF MARINE SCIENCE, vol.2, No.3, p.111-133, 1974.

Identifies and describes the impact of dredging in D'Olive Bay, with respect to the effects of spoil effluents on water conditions and mechanical disruption of benthic habitats. The following were measured during the study: water

temperature, dissolved oxygen, salinity, turbidity, and current direction, sediment particle size distribution and sedimentation rates; phytoplankton abundance and primary productivity; submersed plant biomass, and abundance, standing crop and diversity of benthic fauna. Eighteen stations were located in the bay at at the edge of Blakeley River. Literature Cited (15 items)

Wakeman, T. Conditions of Pollutants During Dredging and Disposal Operations in San Francisco Bay. Proceedings of a Workshop on Algae Nutrient Relationships in the San Francisco Bay and Delta, held November 8-10, 1973 at Clear Lake, California, p.195-202. The San Francisco Bay and Estuarine Association, 1975. (See annotation in Section IV.)

Wakeman, T.H., Sustar, J.F., and Dickson, W.J. Impacts of Three Dredge Types Compared in S.F. District. WORLD DREDGING & MARINE CONSTRUCTION, vol.11, No.3, p.9-14, February 1975.

The article summarizes a paper presented at WODCON VI in September, 1974. The paper is based on monitoring of Corps of Engineers dredging operations in San Francisco Bay. Maintenance dredging in the bay is conducted with hopper dredges generally beginning in October and continuing through the spring. The work presented in the paper was expanded starting in October, as part of a $2.7 million study of the environmental impact of dredging in the bay. The overall study is scheduled for completion in the second half of 1975. The emphasis of the monitoring during this dredging period is the quantification of the plume generated by hopper dredging and clamshell dredging using various federal projects in the bay. Continuous monitoring using floating stations at set depths is now being conducted in lines parallel with the dredging operation to further quantify the effects. Distance or area of influence is delineated by incorporating direct measurements with the speed of the dredge and/or the currents. Percent transmission data obtained with a 10 centimeter light path instrument is combined with data from water samples analyzed for suspended solids concentrations. Correlation analysis between the field percent transmission readings and the laboratory analysis of suspended solids reveals major differences in optical properties, due mainly to the differences in salinities in the bay. Evaluation of the relative impact of various dredging operations requires a complete understanding of the various parameter measurements.

Walther, A.W. Research in the Haringvliet Estuary. Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, Copenhagen, Denmark, vol.III, 1975, Chapter 146 (p.2483-2494). (See annotation in Section II.)

Walton, T.L., and Dean, R.G. Use of Outer Bars of Inlets as Sources of Beach Nourishment Material. SHORE AND BEACH, vol.44, No.2, p.13-19, July 1976. (See annotation in Section II.)

Wash Estuary Storage Feasibility Study. WATER SERVICES, vol.79, No.948, p.77-79, February 1975.

Gives a review of engineering as well as ecological studies done to date as well as future studies to be executed on the 3 or 4 bunded fresh water reservoirs to be built just offshore as an acceptable alternative to an enclosure of the whole or of the inner half of the Wash.

Weel, M.A. van. Le Canal du Rhin a l'Escaut. Amenagements de l'Estuaire de l'Escaut (The Rhine-Scheldt Canal. Improvement Works in the Scheldt Estuary). Bulletin of the Permanent International Association of Navigation Congresses, No.17, p.37-41, 1974. (In French, English summary.)

The Rhine-Scheldt canal improvement works, creating a shipping link between Antwerp and the Volkerak waterway in the Netherlands, are described. Cross-section is based on model experiment results, making the canal suitable for push-tow shipping. Locks divide the canal into two sections, and are designed to guarantee optimum separation of fresh and salt water. Discussed are the Baalhoek canal and the cutting off the bend near Bath.

Whalin, R.W. Hydraulic Model Evaluation of Coastal Evolution Due to Offshore Structures. SHORE AND BEACH, vol.43, No.1, p.9-20, April 1975. (See annotation in Section VI.)

Wilson, J.F., Lowrey, D.P., and Millan, J.D. Dredging with Tidal-Powered Jets. Eighth Annual Offshore Technology

Conference, Houston, Texas, May 3-6, 1976; Proceedings, vol.III, Paper No.OTC 2585. (See annotation in Section VI.)

Windom, H.L. Unconfined Dumping of Dredge Spoil Said Better than Dike Method. THE WORK BOAT, vol.29, No.10, p.36, 38, 40, 42, October 1972. (See annotation in Section II.)

Wing, R.H., Editor. A Test Particle Dispersion Study in Massachusetts Bay. U. S. National Oceanic and Atmospheric Administration, NOAA Technical Report ERL 374-MESA 6, September 1976. (See annotation in Section VII.)

SECTION VI. MODELING AND OTHER LABORATORY EXPERIMENTS

Physical and mathematical model studies and other controlled experiments connected with any phase of tidal hydraulics. Investigations of theoretical aspects, studies for improvement or regulation at specific localities, theory of physical model design and operation, physical model appurtenances, and types of problems susceptible of model analysis.

Abbott, M.B., Dahl-Madsen, K.I., Hinstrup, P.I., et al. River and Estuary Modeling with the Siva System. Symposium on Modeling Techniques, 2nd Annual Symposium of the Waterways, Harbors and Coastal Engineering Division of ASCE, San Francisco, California, September 3-5, 1975, vol.I, p.745-763.

The System 11, "Siva," has been extensively field tested for the case of a Danish Fiord, the Limfiord, which is multiplely connected and has a total length of about 100 miles. This fiord is open at both ends to the sea, where it is subject to tidal and storm surge variations, while its internal conditions are also much affected by wind. The paper shows various outputs from the field tests. Some other applications are also outlined. The System is used to calculate the effects of various pollution loads and distributions under typical climatological conditions. From these calculations, the best locations and capacities of waste treatment plants are to be determined. References (5 items).

Abraham, G., Karelse, M., and Lases, W.B.P.M. Data Requirement for One-Dimensional Mathematical Modelling of Salinity Intrusion in Estuaries. Delft Hydraulics Laboratory, Publication No.149, November 1975. Same in: Proceedings, XVIth Congress of the International Association for Hydraulic Research, São Paulo, Brazil, July 27 to August 1, 1975, vol.3, Paper C32.

One-dimensional real-time modeling requires the magnitude of the longitudinal dispersion coefficient to be specified beforehanded using experimental data. In this paper, analyzing the dispersion mechanism, amongst others, it was found that (i) the dispersion coefficient expresses longitudinally intergrated effects and varies with location and time (ii) information on dispersion obtained in one estuary may not be applied directly for another estuary under all circumstances. Experimental data illustrating the above items are presented. References (11 items).

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Agalakov, S.S., Grigoriev, Y.A., Gun'ko, F.G., et al. Laboratory Investigations into the Pattern of Currents in the Neva Estuary in the Gulf of Finland on Completion of Flood Defence Works for Leningrad. Proceedings, XVIth Congress of the International Association for Hydraulic Research, São Paulo, Brazil, July 27 to August 1, 1975, vol.1, Paper A22.

The paper presents results of laboratory hydraulic studies of a scheme proposed for flood defence of Leningrad. Investigations were carried out on two models: a three-dimensional hydraulic model, scaled 1:2000 horizontally and 1:100 vertically, reproducing dikes with sluices and navigational openings, and an aerodynamic model scaled 1:5000 and 1:150, respectively. The effect of the defence structures on the hydraulic conditions in the protected zone of the Neva estuary was studied, i.e. currents set up by the Neva flow and by the inrush of water from the Gulf of Finland associated with storm surges. The results obtained were used for an adequate selection of the location and size of sluices in the barrier structure, so as to preserve the present water exchange regime in the central part of the protected zone and to improve it in the coastal areas. References (4 items).

Ages, A.B. A Numerical Model of Victoria Harbour to Predict Tidal Response to Proposed Hydraulic Structures. Environment Canada, Marine Sciences Branch, Pacific Region, Pacific Marine Science, Report No.73-3, March 1973.

A number of schemes have been proposed to improve the water quality of the upper basin of Victoria Harbour. These include construction of a dam to prevent entry of polluted water and the construction of a canal to flush the basin. Possible changes in tidal behavior as a result of the proposed structures are examined by means of a numerical model. The construction of a dam would amplify a seiche which is normally suppressed by the upper basin while the canal, unless regulated by locks, would, at low water, drain the polluted water into another harbor. To maintain circulation through the canal, the 2 waterways would have to be dredged. At falling tide, most of the upper basin would discharge through the canal, reducing the ebb current in the Narrows to a rate which would make this passage navigable during all tidal phases. References (2 items).

Amein, M. Computation of Flow Through Masonboro Inlet, N.C. Journal of the Waterways, Harbors and Coastal Engineering Division, Proc. ASCE, vol.101, No.WW1, p.93-108, February 1975. Discussion, vol.102, No.WW1, p.105-106, February 1976; Closure, No.WW4, p.480, November 1976.

The Masonboro Inlet system is a complex arrangement of channels connecting the coastal waterways to the Atlantic Ocean. The flow through the system was computed by means of a numerical model based on the equations of unsteady flow which represent the laws for the conservation of

mass and momentum. An implicit method was used to find the solutions for the finite difference equations. The method requires that the basic equations be satisfied at all locations simultaneously. A comparison of the computed results with the field observations demonstrates the accuracy, reliability, and efficiency of the method. It is believed that the simulation model can handle other inlets with little difficulty, because other inlets are generally much simpler than the Masonboro Inlet. References (24 items).

Amein, M., and Wardak, S.G. A Dynamic Water Quality Model for the Neuse Estuary, N.C. University of North Carolina, Sea Grant Program, Sea Grant Publication UNC-SG-75-28, December 1975.

The numerical model consists of two parts. The first part employs an implicit method for the solution of the shallow water hydrodynamic equations. The objective of this part of the work is to obtain the values of discharge, velocity and depth in the estuary under the action of freshwater inflow, surface runoff, winds and tides. The second part of the model uses an explicit method for the solution of the unsteady mass-balance equation (equation of mass transport). The objective of this part of the work is to obtain values for concentration of materials in the estuary. The process can be steady or unsteady, the material can be conservative or nonconservative. Applications of the model to the Neuse Estuary are given and the model is tested with field data for ammonia, nitrates and dissolved oxygen. References (21 items).

Apelt, C.J., and Gout, J.J. Numerical Modelling of Tidal Phenomena in Bays and Estuaries with Inter-tidal Flats. Fifth Australasian Conference on Hydraulic and Fluid Mechanics, University of Canterbury, Christchurch, New Zealand, 9-13 December 1974; Conference Proceedings, vol.II, p.250-257.

A numerical model for simulation of tidal dynamics in bays and estuaries containing large areas of shallows which dry at lower stages of the tide is described. The model incorporates two spatial dimensions in the horizontal plane and the effects of wind shear, of frictional resistance and of Coriolis force are included. The processes of drying and wetting of the intertidal flats are simulated automatically by dynamic alteration of the boundary conditions. Some results from a number of case studies carried out with the model are presented and it is shown that the presence of extensive areas of inter-tidal flats within a basin gives rise to significant and complex effects on the tidal dynamics. References (3 items).

April, G.C., Hill, D.O., and Liu, H.-A. Hydrodynamic and Material Transport Model for Mobile Bay, Alabama. Symposium on Modeling Techniques, 2nd Annual Symposium of the Waterways, Harbors and Coastal Engineering Division of ASCE, San Francisco, California, September 3-5, 1975, vol.I, p.764-782.

The purposes of the study were to formulate a hydrodynamic and material transport mathematical model for Mobile Bay and to investigate the influences that river flow rate, wind direction and speed, coliform loading and bay temperature have on bay behavior using the verified models. Results of a detailed parametric study are reported as tidal cycle average current and salinity profiles, and monthly average coliform profiles. For current and salinity distributions, wind (above 15 knots) effects and river flow rate are significant in shaping the patterns within the bay. Coliform concentration profiles are likewise strongly influenced by river flow rate and water temperature. In all cases, computing efficiency and perceptibility of computer output were of major consideration in the formulation of the Mobile Bay Model. References (10 items).

Ariathurai, C.R. A Finite Element Model for Sediment Transport in Estuaries. Dissertation, Ph.D in Engineering, University of California at Davis, 1974.

A two-dimensional finite element model that simulates erosion, transport and deposition of suspended sediments is developed. Galerkin's weighted residual method is used to solve the transient convention-diffusion equation which is the statement of mass conservation. The domain is subdivided into a series of triangular elements in which a quadratic approximation is made for the suspended sediment concentration. Expressions used for the rate and conditions under which erosion and deposition occur are those postulated by Krone and Parthenaides. Continuing aggregation is accounted for by stipulating the settling velocity of the flocs in each element. A table of salinities at which different clay types become cohesive is presented. The solution is stable and convergent for the range of Peclet numbers encountered in river, reservoir and estuary problems. A flume test was carried out to verify the model and showed good agreement between observed and predicted shoaling patterns.

Analytic verification of the numerical scheme, computer program listing and description are also presented. References (50 items).

Ariathurai, R., and Krone, R.B. Finite Element Model for Cohesive Sediment Transport. Journal of the Hydraulics Division, Proc. ASCE, vol.102, No.HY3, p.323-338, March 1976.

A mathematical model that simulates erosion, transport and deposition of cohesive sediments in a two-dimensional flow field is presented. The governing equations are solved by the finite element method using the Galerkin formulation. The domain is subdivided into a series of triangular elements in which a quadratic approximation is made for the suspended sediment concentration. Expressions used for the rate and conditions under which erosion and deposition occur are from previous experimental studies. Continuing aggregation is accounted for by specifying the settling velocity of the flocs in each element. The model is verified by comparison with analytic solutions and the results of a flume test. References (17 items).

Ariathurai, R., and Krone, R.B. Mathematical Modeling of Transport in Estuaries. Estuarine Processes; Volume II, Circulation, Sediments, and Transfer of Material in the Estuary, edited by Martin Wiley. New York, Academic Press, 1977, p.98-106.

The elements to be considered in a mathematical model for estuarial sediment transport are presented. These elements include convection-diffusion terms and source and sink functions based on previous laboratory experiments. The experimental results yielded descriptions of deposition from suspension and erosion of cohesive beds. Mathematical models that simulate the transport of cohesive sediments are reviewed with recommendations for future work. References (13 items).

Audunson, T., Mathisen, J.P., Naeser, H., et al. Comparison Between Physical and Mathematical Modelling of a Tidal Fjord System in Northern Norway. Symposium on Modeling Techniques, 2nd Annual Symposim of the Waterways, Harbors and Coastal Engineering Division of ASCE, San Francisco, California, vol.II, September 3-5, 1975, p.1291-1310.

Paper presents results from a physical and numerical model study of a tidal fjord system with three tidal inlets in northern Norway. The velocity field in the distorted physical model is shown to be in good agrrement with available field data. The tidal velocity fields computed from a two-dimensional vertically integrated numerical model shows fair agreement with observations from the physical model. The computations showed little effect from the earth rotation. Stability of the numerical calculations required the incorporation of a diffusion term in the equations of motion. Numerical computations of spreading and dilution of tracer material employed a vertically integrated two-dimensional diffusion-advection model. In these computations use was made of the solution of the equations of motion. The numerical results were compared to similar results from the physical model. Agreement was found at some locations, disagreement at others. Diffusion effects in the distorted physical model seem larger than what was obtained in the numerical computations using a diffusion coefficient of 0 (10^5 cm^2/s). The results strongly emphasize the importance of adequate data for comparison with numerical computations before such models may be used with confidence. References (10 items).

Aydin, F.N., and Ahlert, R.C. A New View of Dispersion in Well-Mixed Estuaries. ECOLOGICAL MODELLING, vol.5, No.4, p.301-326, November 1978.

A two-dimensional simulation of Delaware estuary hydrodynamics has been constructed. This simulation has been achieved through a rational estimate of the character of natural turbulence. Non-homogeneous velocities, on the cross-section, are employed in two-dimensional, laterally homogeneous species mass balances. In turn, concentration profiles are interpreted in the form of classical, one-dimensional dispersion coefficients. Variation of dispersion as a function of both freshwater inflow and longitudinal distance was generated. Variation of dispersion in time within a tidal cycle was found to be insignificant while no significant variation from one tidal cycle to the next has been detected. The modeling process involves the solution of tractable equations by implicit numerical methods and is capable of being excited by a wide range of input conditions. A study of the sensitivity of dispersion due to vertical mass diffusion revealed that longitudinal mixing characteristics are inversely proportional to vertical eddy diffusivity and analysis of the numerical results showed the dispersion coefficient is essentially insensitive to variation of longitudinal mass diffusivity. This leads to the conclusion that turbulent diffusivity of mass

in the longitudinal direction may be taken as constant for most purposes in the study of a two-dimensional species mass balance model. A field program was carried out near the Delaware Memorial Bridge to collect velocity profiles. Substantial portions of the scheme have been verified (i.e. one- and two-dimensional tidal dynamic models) through the use of these data. References (27 items).

Ball, D.J., and Cox, N.J. Hydrodynamic Drag Force on Groups of Flat Plates. Journal of the Waterway, Port, Coastal and Ocean Division, Proceedings, ASCE, vol.104, No.WW2, p.163-173, May 1978. (See annotation in Section I.)

Barailler, L. Aménagement de l'estuaire de la Seine. Rejets de gypse en conduite (Development of the Seine Estuary. Discharge of a Gypsum from a Pipe). LA HOUILLE BLANCHE, vol.29, No.1/2, p.67-70, 1974. (In French.) (See annotation in Section IV.)

Barailler, L., Cunge, J.A., and Montaz, J.P. Etudes sur modèles physiques et mathématiques de l'évolution des fonds due à la marée dans les estuaires; Application à l'estuaire de le Seine (Studies on Physical and Mathematical Models of the Evolution of the Beds of Estuaries - Applied to the Estuary of the Seine). Proceedings, XVIth Congress of the International Association for Hydraulic Research, São Paulo, Brazil, July 27 to August 1, 1975, vol.1, Paper A3. (In French.)

Morphological process in estuaries can be investigated by means of scale or mathematical models, two very different methods which, however, almost invariably complete each other. This paper shows the respective advantages and drawbacks of the two methods and the extent to which they are complementary. A study of the River Seine Estuary is described as a typical application of both methods together. This approach improves reliability of results and decreases investigation costs. References (5 items).

Barber, F.G., Murty, T.S., and Taylor, J. A Preliminary Tidal Exchange Experiment in Masset Inlet. Marine Sciences Directorate, Department of the Environment, Ottawa, Canada, Manuscript Report Series No.39, 1975. (See annotation in Section I.)

Bard, H., and Krutchkoff, R.G. A Stochastic Model for the James. Virginia Polytechnic Institute and State University, Blacksburg, Water Resources Research Center, August 1973.

Modeling the James River Estuary and determining parameter sensitivity were major objectives of the project. The Schofield Model, a transient state model, simulated the James River using the available investigations for input data information. The sensitivity of the model predictions to changes in rate constants, fresh water flow rates, sewage input, and temperature was also investigated.

Barrett, M.J., and Mollowney, B.M. Pollution Problems in Relation to the Thames Barrier. Philosophical Transactions of the Royal Society of London, Mathematical and Physical Sciences, vol.272, No.1221, p.213-221, May 4, 1972.

Although the storm-surge barrier on the Thames, which is to be constructed about 15 km seaward of London Bridge, need only be closed to exclude exceptionally high tides to fulfill its primary function as a flood-prevention device, it could also be operated as a tide-control structure. A theoretical study to assess the effect of operating the barrier on the Thames estuary on a regular basis to prevent water levels from falling below a fixed datum is outlined. Studies on a large-scale physical model indicate that tide control would bring about fundamental changes in the estuary. The tidal range would be reduced, and current velocities would fall to almost zero. There would be a consequent reduction in tidal range and hence, in the tidal excursion. There would also be changes in salinity. The upstream limit of the saltwater would be displaced some 4 km farther seaward. When tide control was discontinued the original salinity distribution would quickly be reestablished. A one-dimensional, time-dependent numerical model, which encompasses the ebb and flow of the tide, was also developed. (KNAPP-USGS.) References (5 items).

Barwis, J.H. Annotated Bibliography on the Geologic, Hydraulic, and Engineering Aspects of Tidal Inlets. U S. Army Corps of Engineers, General Investigation of Tidal Inlets, GITI Report 4, January 1976. (See annotation in Section VIII.)

Basu, A.N. Inclusion of Actual Bed Slope of a Tidal River in Hydrodynamical Model.

In: Proceedings, Forty-Fourth Annual Research Session, Chandigarh, 29 January - 1 February 1975, Volume II - Hydraulics. Central Board of Irrigation and Power (India), Publication No.123, January 1975, p.128-133. (See annotation in Section I.)

Bennett, J.P. General Model to Simulate Flow in Branched Estuaries. Symposium on Modeling Techniques, 2nd Annual Symposium of the Waterways, Harbors and Coastal Engineering Division of ASCE, San Francisco, California, September 3-5, 1975, vol.I, p.643-662.

The model simulates the time history of stage and discharge in any estuary that can be idealized as a system of interconnected one-dimensional open channels. A unique coding system included in the model input as a part of the description of each cross-section enables the solution algorithm to treat any network of channels without modification of Fortran coding. There are no restrictions as to the number of reaches or junctions that can be considered because the algorithm computes stage and discharge for each cross-section without reference to its location in a particular channel reach or at a junction. Stage and discharge are computed in each channel using an implicit finite difference technique in which the equations of motion are linearized over a time step. The implicit relationship is carried from one channel to others intersecting it by equating stages, and utilizing a continuity equation for the junction. The implicit formulation removes the Courant restriction on the size of the time step. The amount of core storage is minimized by taking advantage of the banded nature of the coefficient matrix. Object time dimensioning is used so that only one set of dimension statements need to be changed when problems of different size are considered. Application of the model is illustrated using an extensive data base collected in the Portland, Oregon, harbor on the Willamette and Columbia Rivers. The harbor is idealized as a set of seven interconnected one-dimensional channels. After calibration, the model reproduces observed stages to within a RMS error of 0.2 ft., and discharges to within a RMS error of less than 50 percent of the average absolute value. References (8 items).

Benson, C.A., Hann, R.W., Jr., and Reynolds, T.W. Analytical Models for the Evaluation of Supplemental Aeration in Texas Estuaries. Texas A&M University, Environmental Engineering Division, Sea Grant College, TAMU-SG-75-213, January 1976.

In this study a one-dimensional dynamic mathematical model was developed for computer solution of estuarine dispersion problems. The math model was based on the one-dimensional mass transfer equation for the longitudinal distribution of a substance in a variable area estuary. Finite-difference approximations of the mass transfer equation were used to develop the numerical model. Several researchers have used similar modeling techniques, and their work has been summarized in the Literature Review. The mathematical model described in this work was applied to three dispersion problems. The first problem considered was the distribution of organic wastes in the Corpus Christi Harbor Channel. The goal of this study was to determine the effect of waste discharges on the organic loading in the Harbor Channel. Design of a surface aeration system for Vince Bayou was the second application of the math model. The third application of the computer program was to determine the effect of inchannel aeration on dissolved oxygen levels and organic waste concentrations in the Houston Ship Channel. References (57 items).

Billen, G., and Smitz, J. Mathematical Model of Water Quality in a Highly Polluted Estuary. Hydrodynamics of Estuaries and Fjords; Proceedings of the 9th Liege Colloquium on Ocean Hydrodynamics, 1977, p.55-62.

The paper describes a general model of water quality in high polluted rivers and estuaries, showing the relations between the oxido-reduction balance, bacterial activity and hydrodynamic processes. Systematical application is made to the Escaut river estuary. The Scheldt estuary (120 km long) is heavily polluted above Antwerp (km 80) by important amounts of organic matter. The deterioration of chemical and biological properties of the water by this domestic pollution is not the direct consequence of the presence of organic load, but the result of the intense heterotrophic activity which degrades this charge: oxygen is rapidly entirely depleted; other oxidants (MnO_2, NO_3, $Fe(OH)$,...) are used by anaerobic metabolisms, and the related reduced forms (Mn^{++}, NH_4^{++}, Fe^{++},....) are produced (km 120 - km 70). Near km 60, owing to increasing salinity, flocculation and sedimentation of the suspended organic matter occur. Under the conjugated increase of salinity and

disparition of organic matter, the bacterial activity falls down, and a phase of recuperation begins (km 30 - km 60), acceleration by mixing with sea-water, saturated in oxygen. The different oxidants are successively regenerated; the last step is the reapparition of oxygen. Typical longitudinal profiles of oxido-reduction forms are shown in Fig. 1.a.b. In this case, the classical models of river pollution cannot be used: i) the organic load is very important, and is not a limiting factor of the heterotrophic activity; ii) other oxidants than oxygen are used, and must be considered as state variables. It is, however, possible to describe correctly the evolution of the chemical composition of the water by a complete oxido-reduction balance, using a few assumptions about internal thermodynamic equilibrium. References (13 items).

Blair, C.H. Similitude of Mass Transfer Processes in Distorted Froude Model of an Estuary. Ph.D. Dissertation, Old Dominion University, Norfolk, Virginia, March 1976.

The project began with the design and construction of a hydraulic Froude model of the Lafayette River, a small well mixed estuary in Norfolk, Virginia. Horizontal scale is 1/540, verticle scale 1/12 yielding a vertical distortion of 45. Adjustment by roughness strips and screens produced close agreement of model-prototype tide heights, currents, and salinities in the deep reaches comprising 80% of the estuary volume. Some scale effect in velocity and tide height could not be eliminated in the shallow upper branches of the estuary, probably because of the high geometric distortion and the narrowness of the channel at kilometer 6.7. Similar slug releases of Rhodamine WT dye tracer in model and prototype produced concentration fields which were monitored over eight tidal cycles. The normalized concentration fields were in close agreement in the lower reaches. In the shallow upper branches, model concentrations increased to about double those in the prototype as depth decreased. Using an analytic solution to the one-dimensional advection-diffusion equation, values of low- and high-water slack dispersion coefficients were computed for model and prototype. Their mean was taken as an approximation of the real-time coefficient. By running the model with fresh water as well as with fresh/salt mixed, it was possible to separate the dispersion coefficients into components dependent upon oscillatory turbulent velocity shear and upon density gradients. The model-to-prototype ratio of turbulent velocity shear components must be of order 10^{-4} for similitude of dispersion. If the Taylor-Elder equations for dispersion coefficient apply, the actual ratio will be of order 10^{-1}; if on the other hand the "four-thirds law" applies, the actual ratio will be of order 10^{-4} as required for similitude. Data from the Lafayette River model agreed closely with the latter. Model-prototype comparisons of dispersion in several other models at varying scales and distortions have also been reported to demonstrate similitude, as would be predicted by the four-thirds law. It appears that this is the governing relationship for dispersion coefficients in at least nine models; consequently, similitude of mixing is attainable in at least these and possibly other estuaries. No particular restriction on the relationship between horizontal and vertical scales is necessary. An analysis of the derivation of the one-dimensional longitudinal dispersion equation shows that the coefficient is in fact the sum of two terms, one related to the Taylor-Elder concept (mixing due to velocity shear and small-scale eddies) and the other to the four-thirds law (mixing due to large-scale eddies). More research is needed to determine, for any given estuary, the relative magnitude of the two components. References (53 items).

Blank, M.A. Results of Salinity Tests on the San Francisco Bay-Delta Hydraulic Model. Symposium on Modeling Techniques, 2nd Annual Symposium of the Waterways, Harbors and Coastal Engineering Division of ASCE, San Francisco, California, September 3-5, 1975, vol.I, p.663-674.

As part of the San Francisco Bay and Sacramento-San Joaquin Delta Water Quality and Waste Disposal Investigation of the Corps of Engineers, U. S. Army Engineer District, San Francisco, hydraulic model tests were conducted at the Corps' fixed bed hydraulic (physical) model in Sausalito, California. These tests included: verification for tidal elevations, velocities and salinities; model sensitivity; base and plan conditions. Steady state tests were found satisfactory for measuring tidal elevations and velocities. Dynamic tests were required to obtain salinity results for comparison of base and plan conditions. The specific problem addressed is the effect that channel deepening would have on salinity at selected stations in the estuarine system. While in general deepening of navigation channels increased salinities, there were cases where deepening of the upper reaches of the channel caused small

changes in salinity throughout the system. It may be that the location of a critical mixing zone determines the influence of channel deepening on salinities. Regardless of what theories are used to explain phenomena, the model test results indicate what will occur in the prototype for each of the plans tested. Results can then be used by a specialist to determine the impact on the estuarine environment. References (6 items).

Blumberg, A.F. The Influence of Density Variations on Estuarine Tides and Circulations. ESTUARINE AND COASTAL MARINE SCIENCE, vol.6, No.2, p.209-215, February 1978. (See annotation in Section I.)

Blumberg, A.F. A Numerical Investigation into the Dynamics of Estuarine Circulation. Chesapeake Bay Institute, The Johns Hopkins University, Technical Report 91, Reference 75-9, October 1975. (See annotation in Section I.)

Blumberg, A.F. Numerical Model of Estuarine Circulation. Journal of the Hydraulics Division, Proc. ASCE, vol.103, No.HY3, p.295-310, March 1977.

A real-time numerical model is developed to predict the dynamics of partially mixed estuaries. An explicit finite difference technique which conserves mass, salt, and momentum was used to solve the governing equations. A consistent set of vertical mixing coefficients is proposed such that an application of the model to the Potomac River Estuary produces simulations of velocity, salinity, and tidal heights comparable to field observations. The model also permits an investigation of the time variability in the magnitude of the various terms composing the salt balance equation. References (19 items).

Blumberg, A.F. Numerical Tidal Model of Chesapeake Bay. Journal of the Hydraulics Division, Proc. ASCE, vol.103, No.HY1, p.1-10, January 1977.

A two-dimensional plan view numerical model based upon the shallow water equations is developed to simulate the tidal dynamics of complex estuaries, rivers, and bays. The finite difference technique conserves mass, momentum (with no dissipation) and energy. The technique also allows for easy employment of boundary conditions and uses little computer time. The model is applied to the Chesapeake Bay with its varying bathymetry and many tributaries, showing the simulations to accurately predict available observations. The presence of residual eddies was detected. Numerical simulations of the Bay demonstrate that a bottom friction coefficient of K = 0.0025 (C = approx. 63) is appropriate. References (9 items).

Blumberg, A.F. A Two-Dimensional Numerical Model for the Simulation of Partially Mixed Estuaries. Estuarine Processes; Volume II, Circulation, Sediments, and Transfer of Material in the Estuary, edited by Martin Wiley. New York, Academic Press, 1977, p.323-331.

A real time numerical model is developed to describe the longitudinal and vertical distributions of velocities and salinities as well as tidal amplitudes for partially mixed estuaries. One assumes the flow to be laterally homogeneous and uses realistic estuarine bathymetry. The external inputs to the model are the salinity and tidal amplitude as a function of time at the ocean boundary and the freshwater discharge at the river boundary. The model includes the continuity, salt and momentum balance equations, coupled by an equation of state. The elimination of the lateral momentum balance equation permits numerical solutions with little computing time. The numerical technique conserves salt, volume and momentum in the absence of dissipative effects. Simulations show the salinity intrusion to be highly sensitive to the vertical eddy viscosity, with minor changes to the tidal amplitude. Results from the application of the model using a stability dependent eddy viscosity and eddy diffusivity to the Potomac River yield distributions comparable to field observations. References (3 items).

Boericke, R.R., and Hogan, J.M. An X-Z Hydraulic/Thermal Model for Estuaries. Journal of the Hydraulics Division, Proc. ASCE, vol.103, No.HY1, p.19-37, January 1977.

A two-dimensional time dependent numerical model for partially stratified estuaries is described. The model is based on a coupled solution to the continuity, momentum, and salinity equations in the longitudinal (x) and vertical (z) directions. The hydrostatic approximation is used, and the vertical exchange of momentum, mass and energy is modeled with an eddy viscosity using empirical modifications for stable and unstable stratification. The numerical method is a time and space staggered scheme with the vertical direction treated implicitly. Convection terms in the transport equations are treated with upwind differencing. The model results show good agreement with observed tidal phase lag, current and

salinity data. At low freshwater flows, the model predicts a large density-induced circulation (DIC), which strongly influences the dilution of thermal discharges. An important result is that the DIC is not monotonic, being much larger in the deep sections of the river due to recirculation. References (25 items).

Bokuniewicz, H.J. Estuarine Sediment Flux Evaluated in Long Island Sound. Ph.D. Dissertation, Yale University, May 1976. (See annotation in Section II.)

Bonnefille, R., Lepetit, J.P., and Lespine, E. Simulation des depôts de vase dans l'estuaire de la Gironde (Simulation of Silt Deposition in the Gironde Estuary). Proceedings, XVIth Congress of the International Association for Hydraulic Research, São Paulo, Brazil, July 27 to August 1, 1975, vol.1, Paper A24. (In Frecnh.) (See annotation in Section II.)

Bonz, P.E. Fabric Boom Concept for Containment and Collection of Floating Oil. U. S. Environmental Protection Agency, Environmental Protection Technology Series, EPA-670/2-73-069, September 1973. (See annotation in Section V.)

Bowden, K.F., and Hamilton, P. Some Experiments with a Numerical Model of Circulation and Mixing in a Tidal Estuary. ESTUARINE AND COASTAL MARINE SCIENCE, vol.3, No.3, p.281-301, July 1975.

A two-dimensional model of estuary circulation, of which a mathematical description has been published previously, has been applied to a study of the changes in circulation and salinity distribution which occur in an estuary of simple geometrical shape when certain parameters of the flow are varied systematically. The estuary is of rectangular cross-section but the width and depth vary along its length. The boundary conditions include a simple harmonic tidal oscillation applied at the mouth and a uniform river discharge at the head of the estuary. Two internal parameters, the coefficients of vertical eddy viscosity and diffusion, N_z and K_z, respectively, have been taken (i) as constants, (ii) as functions of the depth of water and the depth-mean current, and hence varying with time, and (iii) as functions also of the Richardson number. It was found that the use of variable coefficients, N_z and K_z, instead of constant values, had a considerable effect on the vertical profiles of current and salinity during a tidal period and gave a representation closer to observational data Experimental runs with different values of the tidal amplitude, the river flow and end salinities being kept constant, showed the effects of interaction between the tidal-driven and density-driven components of the flow. Other runs were made with varying river discharge and horizontal salinity gradients. It is considered that the results of these tests will be useful in the application of similar models to real estuaries References (20 items).

Bowen, A.J., and Pinless, S.J. Effects of Bank Raising Along the Thames. Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, Copenhagen, Denmark, vol.III, 1975, Chapter 145 (p.2471-2482).

A one-dimensional numerical model was used to estimate the location and volumes of water flooding over the banks of the Thames Estuary under several combinations of bank levels and possible storm surges. An assessment of the probable damage resulting from each of these floods enabled a comparison to be made between the various possible schemes for bank improvement and, indeed, showed that there was a serious need for such improvement even though a start on the construction of the Thames Barrier was imminent. In an estuary such as the Thames the overflow may provide a significant turn in the continuity equation and the effect must therefore be programmed as an integral part of the model; one obvious effect of the overspill is to limit the maximum levels to about 0.2 m above the banks in the upper Thames, almost irrespective of the size of the surge. References (3 items).

Bowen, A.J., and Pinless, S.J. The Response of an Estuary to the Closure of a Mobile Barrier; Richmond Barrier on the Upper Thames Estuary. ESTUARINE AND COASTAL MARINE SCIENCE, vol.5, No.2, p.197-208, March 1977.

The changes in tidal regime and extreme levels in the River Thames which will result from the closure of the Woolwich Barrier have been estimated from the results of both hydraulic and numerical models of the estuary. It was clearly important that the assumptions and methods used in these models be checked as thoroughly as possible; one obvious way of verifying the numerical model was to use the same techniques to investigate the effects of an existing structure, the half-tide barrier at Richmond, where the predictions could be checked

against direct observations. A detailed, one-dimensional, numerical model of the Thames Estuary above Chelsea was developed to examine the dynamics of this complex region; a region which had been represented only very crudely in previous models of the whole estuary. The model was found to accurately describe the tidal regime in this area, correctly reproducing the effect of a mobile barrier closing across the tide. Opportunities for the detailed verification of numerical model predictions of the changes resulting from a major alteration in the geometry of the system are rare, usually only being possible in a follow-up study after a new structure has been completed. It is therefore encouraging that the present model successfully reproduces the dynamics of an existing system. References (5 items).

Brandes, R.J., and Masch, F.D. Estuarine Ecologic Simulations. Symposium on Modeling Techniques, 2nd Annual Symposium of the Waterways, Harbors and Coastal Engineering Division of ASCE, San Francisco, California, September 3-5, 1975, vol.I, p.159-178.

The estuarine ecologic model described herein provides a management tool for analyzing the water quality and biological responses of certain types of estuarine systems under the influence of different external inputs, i.e. river inflow quantities and qualities, wastewater return flows and pollutant loadings, local runoff characteristics, tidal behavior, meteorologic conditions, bathymetric changes (dredging) etc. The model simulates the areal distribution of constituent concentrations in a horizontal plane; however, at any given point, complete vertical mixing is assumed. Hence, the model is most applicable to estuarine systems characterized by large surface areas and relatively shallow depths where wind-induced mixing is prevalent. Literature Cited (12 items).

Brezina, J. Experience with a Small Scale, Highly Distorted Fixed Bed Model of the Lago Maracaibo Estuary. Symposium on Modeling Techniques, 2nd Annual Symposium of the Waterways, Harbors and Coastal Engineering Division of ASCE, San Francisco, California, September 3-5, 1975, vol.I, p.675-689.

The construction of a 13.50 m deep navigation channel through the shallow parts of the Gulf of Venezuela and Lago Maracaibo estuary was completed in 1963. The channel was built principally for the tankers which are used to transport crude oil from the fields located in the land enclosed body of water, commonly called Lago de Maracaibo. The field surveys made periodically after the channel was built have shown an increase in the salinity of the Lago de Maracaibo and the formation of shoals in various parts of the channel. To control the shoaling it was necessary to dredge the channel frequently. This operation, which later became continuous, required heavy financing for the maintenance of the channel. In 1968, the situation in the estuary of the Lago de Maracaibo was critically analyzed. It was concluded that the hydrodynamics of the estuary were not well understood, mainly because of limited field data, inadequate to shed light upon the highly complicated condition of the estuary. However, it was believed that the existing information, especially the continuous tidal records, made it feasible to build and operate a small fixed bed model which, as it was hoped, would provide an insight into the condition of the estuary more readily than any other procedure could do.

Bricker, O.P., III, and Troup, B.N. Sediment-Water Exchange in Chesapeake Bay. In: Estuarine Research, Volume I: Chemistry, Biology, and the Estuarine System, edited by L. Eugene Cronin, Academic Press, Inc., New York, 1975, p.3-27. (See annotation in Section II.)

Brooks, N.H. Dispersion in Hydrologic and Coastal Environments. W.M. Keck Laboratory of Hydraulic and Water Resources, California Institute of Technology, Report No.KH-R-29, December 1972. Same: U. S. Environmental Protection Agency, Pacific Northwest Environmental Research Laboratory, Report EPA 660/3-73-010, August 1973. 136p. (See annotation in Section IV.)

Bruun, P. Stability of Tidal Inlets; Theory and Engineering. New York, Elsevier, 1978. 506p. (See annotation in Section II.)

Burt, W.V., and Farreras, S.F. Predictive Nomograms of Hydraulic Conditions for the Siuslaw Estuary. SHORE & BEACH, vol.45, No.3, p.45-48, July 1977.

In the study, a one dimensional numerical model developed by Goodwin was applied to the Siuslaw estuary and tested under different seasonal water mixing conditions. The model requires physical characteristics of the estuary, tidal fluctuations at the mouth, and fresh water river flow as input. The model output consists of values for water surface displacement,

velocity and tidal flow as a function of time and distance from the mouth. Model results for a number of different hydraulic conditions in the Siuslaw estuary are summarized as a set of nomograms which provide useful information for engineering calculations. References (18 items).

Calciati, A. Le modele fluvio-maritime de Porto Tolle. Proceedings, XVIth Congress of the International Association for Hydraulic Research, São Paulo, Brazil, July 27 to August 1, 1975, vol.1, Paper A26. (In French.)

This paper deals with the fluvial maritime model of delta Po, for the Porto Tolle thermoelectric power station under design. Difficulties encountered during design and tests owing to a tidal range of intermediate value and sea currents having irregular direction and speed in time are examined. After a short description of the model, a method is described to reproduce sea currents which can maintain the similitude for current direction and speed in the area near the coast.

Cannon, G.A., and Laird, N.P. Variability of Currents and Water Properties from Year-Long Observations in a Fjord Estuary. Hydrodynamics of Estuaries and Fjords; Proceedings of the 9th Liege Colloquium on Ocean Hydrodynamics, 1977, p.515-535. (See annotation in Section I.)

Caponi, E.A. The Simulation of Estuarine Circulations with a Fully Three-Dimensional Numerical Model. Estuarine Processes; Volume II, Circulation, Sediments, and Transfer of Material in the Estuary, edited by Martin Wiley. New York, Academic Press, 1977, p.332-346.

The Navier-Stokes salinity and continuity equations in the Boussinesq approximation are spatially integrated on the elementary computational cells to provide equations for the temporal rate of change of the fluxes through every cell's face and of the mean salinity in every cell. The effect of the spatial subgrid scales is lumped together with the Reynolds stresses generated by the temporal discretization procedure, and modeled by a simple Fickian relationship. The pressure field in the momentum equations is split up into a hydrostatic and a dynamic part, the latter obtained as the solution to a finite differences Poisson equation. The three momentum equations and the salinity equation are independently updated by a forward stepping scheme. The free surface is updated by a mass conserving scheme. Required boundary conditions are river inflows and surface elevation at the sea as a function of time, as well as applied winds and atmospheric pressure. The model has been implemented in a Fortran code. It admits arbitrary coastal boundaries, openings to the sea, river inflows and bathymetry imposed by the user through data cards. Idealized test cases are used to show that the model behaves as physically expected. A coarse application to Chesapeake Bay shows qualitatively correct results and the need to incorporate a less naive representation for the subgrid scales. References (13 items).

Carder, K.L., Palmer, S.L., Rodgers, B.A., et al. Calibration of a Thermal Enrichment Model for Shallow, Barricaded Estuaries. University of South Florida, St. Petersburg, Department of Marine Science, September 1976.

Final report to Office of Water Research and Technology, Department of the Interior. A new, semi-implicit, numerical model of thermal dispersion has been developed. It has been linked to an explicit, tidally driven hydraulics model of a barricaded estuary on the west coast of Florida. The model has been used to predict the distribution of temperature resulting from a seawater-cooled power generation facility near Crystal River, Florida. Manning numbers and diffusion coefficients have been determined for the modeled basin and verified by comparing characteristics of the calculated plume to those of the actual plume. Input variables included tidal height, power plant load, solar irradiance, air temperature, humidity, pressure, and wind speed and direction. After five days of simulation for the period 6/15/75 to 6/19/75, the calculated plume area was within 15% of the measured acreage, and the calculated mean plume temperature differed from the measured value by only 0.05C. References (23 items).

Carter, H.H. Simple One Dimensional Kinematic Model Results for the Bush River and Romney Creek. Chesapeake Bay Institute, The Johns Hopkins University, Special Report 49, Reference 76-2, March 1976.

Report describes simple one dimensional transient state transport, i.e., kinematic, models of the Bush River and of Romney Creek, both potential receivers of excess heat and/or contaminants from the blowdown of any cooling towers associated with a generating station constructed at the site. In addition, the results of an independent verification of the Bush

River model by means of two dye experiments (spring and fall, 1972) are presented together with a quantitative comparison of the two systems as potential receivers of waste according to the two models. References (3 items).

Cederwall, K., and Svensson, T. Sediment Flushing After Dredging in Tidal Bays. Journal of the Hydraulics Division, Proc. ASCE, vol.102, No.HY7, p.935-953, July 1976.

A one-dimensional dispersion model for tidal flushing of suspended material has been formulated. It is suggested that this model can be used to predict the escape of suspended material from an estuarine dredging area out into the adjacent waters. The dispersion model includes a sedimentation function to reproduce the effect of resedimentation. Calibration of the model was carried out in a restoration area by means of in-situ tracer tests and salinity measurements to establish the dispersive properties of the water body. The settling characteristics of the upper sediment layer were established by sedimentation analysis of bottom samples from the dredging area, divided into an organic (polluted) top layer and the underlying inorganic sediment. References (16 items).

Celikkol, B. and Reichard, R. Hydrodynamic Model of the Great Bay Estuarine System. Part I. University of New Hampshire, Mechanics Research Laboratory, UNH Sea Grant Technical Report UNH-SG-153, August 1976.

A numerical hydrodynamic model developed by Connor and Wang has been applied to the Great Bay Estuary system. The model, using the finite element method, was found to be better suited to the complexities of the Great Bay Estuary system than Leendertse's finite difference model. Initial model development has been completed, and qualitatively acceptable results are presented. A numerical experiment was conducted to develop a procedure to be used for selection of critical model parameters in the calibration process. The general scheme for model calibration is presented, and is ready to be implemented, pending receipt of current data collected last summer by the National Ocean Survey. References (21 items).

Chadwick, N.R. The Barmby Tidal Barrage. Journal of the Institution of Water Engineers and Scientists, vol.29, No.7, p.317-335, October 1975. (See annotation in Section V.)

Chapra, S.C., and Nossa, G.A. Documentation for HAR03. A Computer Program for the Modeling of Water Quality Parameters in Steady State Multi-dimensional Natural Aquatic Systems. Second Edition. U.S. Environmental Protection Agency, New York, October 1974. (See annotation in Section V.)

Chatterjee, A.K. Numerical Model of a Tidal River. Bulletin of the Calcutta Mathematical Society, vol.64, No.4, p.151-157, December 1972.

The system of one-dimensional equations of motion and continuity has been widely used to describe approximately the unsteady flow in a tidal river and the solution of these equations represent the flow-conditions at any time at any place of the river. The equations being nonlinear, numerical solutions are only tried with the help of finite-difference methods. Here the explicit finite-difference scheme with diamond grids has been used to solve the equations with the help of a high speed digital computer. The case studied here is that of the river Rupnarain, one of the most important tributaries of the river Hooghly. Unlike river Hooghly, this river Rupnarain is more difficult to solve, as has been shown in this paper. Special attention has been given on the variation of friction factor in the equation of motion. The results obtained were compared to those observed in the river and their closeness is also vividly examined. References (3 items).

Chatwin, P.C. Some Remarks on the Maintenance of the Salinity Distribution in Estuaries. ESTUARINE AND COASTAL MARINE SCIENCE, vol.4, No.5, p.555-566, September 1976. (See annotation in Section III.)

Chen, C.W., Smith, D.J., Jackson, J.D., et al. Organic Sediment Model for Wastewater Outfall. Symposium on Modeling Techniques, 2nd Annual Symposium of the Waterways, Harbors and Coastal Engineering Division of ASCE, San Francisco, California, September 3-5, 1975, vol.I, p.179-207.

In addition to bacterial contamination of beaches, marine wastewater discharges can create environmental problems through accumulation of organic sediments near the outfall. Organic sediment modified the living environment of benthic animals, causing populations to change, composition to shift, and substrates to become enriched by heavy metals or other toxic materials. An organic sediment

model was developed to follow the processes of sediment accumulation through sedimentation, lateral dispersion, decay, resuspension and dispersion of settling particles of sewage origin. The model was applied to four outfalls under various operating conditions. Available data indicate the veracity of the model. Wider applications of the model, better definition of input data, and capability of the model to consider current characteristics at different strata of water column can improve the results. They in turn can contribute to the goal of designing the outfall system for the protection of indigenous biota. References (11 items).

Chen, Y.H., Lopez, J.L., and Richardson, E.V. Mathematical Modeling of Sediment Deposition in Reservoirs. Journal of the Hydraulics Division, ASCE, vol.104, No.HY12, p.1605-1616, December 1978. (See annotation in Section II.)

Chevereau, G., Montaz, J.P., and Crouzet, Ph. Modèle mathematique de pollution par convection d'un traceur conservatif; Son utilisation dans l'étude de l'assainissement du Golfe du Morbihan. Proceedings, XVIth Congress of the International Association for Hydraulic Research, São Paulo, Brazil, July 27 to August 1, 1975, vol.4, Paper D2. (In French.)

The choice of purification methods for a tidal estuary or gulf is subject to the prior determination of the field of currents, and their speed and discharge in the area studied. This stage is prolonged by the calculation of the routing of pollutants. The Morbihan Gulf is a definite case for study. The gulf is polluted by urban and industrial waste which adversely affects shell fish farming and tourism, the two main sources of income for the region. The current study and the pollution study which makes use of a conservative tracer were carried out using mathematical models with a view to improve the present condition and to determine a waste disposal program maintaining the restored state in the case of future development.

Christensen, B.A., and Snyder, R.M. Physical Modeling of Scour Initiation and Sediment Transport in Distorted Tidal Models. Symposium on Modeling Techniques, 2nd Annual Symposium of the Waterways, Harbors and Coastal Engineering Division of ASCE, San Francisco, California, September 3-5, 1975, vol.II, p.927-935.

While the construction and operation of undistorted fixed bed Froude models of hydraulic structures such as spillways, intakes, guide vanes, etc., generally do not present substantial problems, this is not the case when models of entire waterways, estuarine regions and coastal areas are considered. The horizontal extension of such flow systems combined with the need for not too small depths in the model require the operation of distorted models with artificial roughness elements introduced to distort the slope of the energy grade line correctly. Formulas for the size and distribution of these roughness elements are developed and tested in a tidal model of the canal between Little Lake Worth and Lake Worth in Palm Beach County, Florida. Furthermore grain-size model scales which will allow true modeling of scour initiation and sediment transport are developed for lighter than prototype model bed materials, thereby avoiding too small model grain-size. References (8 items).

Christodoulou, G.C., and Connor, J.J. Numerical Modeling of Dispersion in Stratified Waters. Massachusetts Institute of Technology, Sea Grant Program, Report No.MITSG 76-17, November 20, 1976.

A numerical model is developed for the quantitative description of the dispersion process in a two-layer system which represents an approximation for a natural coastal water body during the summer season when a distinct thermocline usually exists. The formulation is based on the convection-diffusion equation, vertically integrated between the layer boundaries. Layer velocities and thicknesses are assumed to be obtained from a separate hydrodynamic model. The quantification of the physical processes of entrainment and mixing through the density interface as well as the horizontal dispersion mechanism is discussed. The model is applied to a particle dispersion experiment carried out recently in the Massachusetts Bay and comparisons with field data are presented. References (16 items).

Christodoulou, G.C., Connor, J.J., and Pearce, B.R. Mathematical Modeling of Dispersion in Stratified Waters. Ralph M. Parsons Laboratory for Water Resources and Hydrodynamics, Department of Civil Engineering, Massachusetts Institute of Technology, Report No.219, October 1976.

A numerical model is developed for the quantitative description of the dispersion process in a two-layer system which represents an approximation for a natural

water body during the summer season, when a distinct thermocline usually exists. The model can handle any passive constituent, dissolved or suspended, possessing vertical mobility and arbitrary decay characteristics, in a domain of irregular geometry and bottom topography. The formulation is based on the convection-diffusion equation, vertically integrated between the layer boundaries. Layer velocities and thicknesses are assumed to be obtained from a separate hydrodynamic model. The processes of entrainment and mixing through the density interface are presented with a unified view and general quantitative expressions in terms of the stability of the system and the mean flow characteristics are proposed. The modeling of horizontal dispersion mechanisms and the relation of eddy diffusivity to the characteristic grid size and of shear dispersion to the local velocity profile are discussed. The numerical model is applied to two particle dispersion experiments carried out recently in the Massachusetts Bay and comparisons with field measurements are presented. References (93 items).

Christodoulou, G.C., Connor, J.J., and Pearce, B.R. Mathematical Modeling of Dispersion in Stratified Waters. Massachusetts Institute of Technology, Department of Civil Engineering, Sea Grant Technical Report No.MITSG 76-14, November 1976.

A numerical model is developed for the quantitative description of the dispersion process in a two-layer system which represents an approximation for a natural water body during the summer season, when a distinct thermocline usually exists. The model can handle any passive constituent, dissolved or suspended, possessing vertical mobility and arbitrary decay characteristics, in a domain of irregular geometry and bottom topography. The formulation is based on the convection-diffusion equation, vertically integrated between the layer boundaries. Layer velocities and thicknesses are assumed to be obtained from a separate hydrodynamic model. The processes of entrainment and mixing through the density interface are presented with a unified view and general quantitative expressions in terms of the stability of the system and the mean flow characteristics are proposed. The modeling of horizontal dispersion mechanisms and the relation of eddy diffusivity to the characteristic grid size and of shear dispersion to the local velocity profile are discussed. The numerical model is applied to two particle dispersion experiments carried out recently in the Massachusetts Bay and comparisons with field measurements are presented. References (93 items).

Christodoulou, G.C., Leimkuhler, W.F., and Ippen, A.T. Mathematical Models of Massachusetts Bay. Part III. A Mathematical Model for the Dispersion of Suspended Sediments in Coastal Waters. Ralph M. Parsons Laboratory for Water Resources and Hydrodynamics, Massachusetts Institute of Technology, Report No.179, January 1974. (See annotation in Section II.)

Christov, C., and Bayractarov, I. Propagation of Sea Wind Waves into the River Beds Estuaring into the Sea and Structures for Their Decreasing. Proceedings, XVIth Congress of the International Association for Hydraulic Research, São Paulo, Brazil, July 27 to August 1, 1975, vol.1, Paper A23.

At the lowest courses of the rivers before their estuaring into the sea, they have comparatively slight bed slopes, therefore very often they provoke backwaters which swamp the low coast area. The courses of such rivers are characterized with many meanders. In order to make use of this swamped coast area, which is very valuable to national economy, it appears necessary to improve (train) the river courses at their lowest sections. By the help of a model made at the Hydraulic Laboratory of the Hydraulic and Irrigation Institute in Sofia, the estuary of Izgrev river which trained flows into the Black sea was studied. Various breakwaters of "I" form were also investigated, constructed as rock-fill dams of dumped rocks, set under various angles to the wave direction as well as river streams under different angles to the wave direction. This study gives the opportunity to investigate wave propagation into rivers with a slight bed slope without antiwave structures on the estuary and tributaries coming into the river courses. These tributaries are with comparatively steep bed slopes and considerable discharge compared with that of the main river. The inflow of such tributaries into the river has a comparatively slight influence on the wave propagation into the lowest part of the river.

Codell, R.B. Digital Computer Simulation of Thermal Effluent Dispersion in Rivers, Lakes, and Estuaries. U. S. Army Missile Research, Development and Engineering Laboratory, Redstone Arsenal, Alabama, Technical Report RS-73-16, 5 November 1973. (See annotation in Section IV.)

Costa, S.L., and Isaacs, J.D. Anisotropic Sand Transport in Tidal Inlets. Symposium on Modeling Techniques, 2nd Annual Symposium of the Waterways, Harbors and Coastal Engineering Division of ASCE, San Francisco, California, September 3-5, 1975, vol.I, p.254-273.

The occurrence of natural flushing action in tidal inlets has long been recognized. Unfortunately, the natural situation is often inadequate for man's desired uses. The traditional solutions of dredging or the erection of sediment barriers are expensive, of short term usefulness, and engender a degree of environmental shock. This investigation involves redirecting a small part of the power in tidal flows in a manner as to greatly modify sediment deposition in such inlets. A small unidirectional secondary flow from ocean to bay disproportionately reduces power available to transport sediment into the channel and similarly increases the power available to transport sediment seaward. The results from hydraulic and computer models indicate that small perturbations to the inlet dynamics achieved in this manner have a large nonlinear effect on the overall transport of sediments in the channel. The amount of change is much greater than might be expected from such small changes in the tidal flow. Recent studies have indicated that model and field data seem to be governed by the same law relating tidal flow and equilibrium channel geometry. Since these are the primary agents governing the results of our experiments, it may be possible to extend the results to real size harbors with substantial meaningfulness. References (10 items).

Cream, P.B. A Numerical Model of Baratropic Mixed Tides Between Vancouver Island and the Mainland and Its Relation to Studies of the Estuarine Circulation. Hydrodynamics of Estuaries and Fjords, Proceedings of the 9th Liege Colloquium on Ocean Hydrodynamics, 1977, p.283-313. (See annotation in Section III.)

Crookshank, N. Numerical Model Studies of Rivers and Estuaries. Proceedings of the First Canadian Hydraulics Conference, held at the University of Alberta, May 10 & 11, 1973, p.315-336.

The state-of-the-art of numerical hydrodynamic modelling of rivers and estuaries in one and two dimensions is well developed. The accuracy is considered sufficient for most engineering purposes. A description of numerical modelling is given, followed by applications to the St. Lawrence, Fraser and St. Clair Rivers. References (3 items).

Damsgaard, A., and Dinsmor, A.E. Numerical Simulation of Storm Surges in Bays. Symposium on Modeling Techniques, 2nd Annual Symposium of the Waterways, Harbors and Coastal Engineering Division of ASCE, San Francisco, California, September 3-5, 1975, vol.II, p.1535-1551.

A two-stage approach for numerical simulation of storm surges in complex coastal areas has been adopted by the Danish Hydraulic Institute. The first stage simulates the open coast surge on a large and relatively coarse model including enough area that the surge is generated entirely within the model. The second stage routes the open coast surge into the nearshore area and superimposes the locally generated surge on top of the open coast surge. This method is particularly suited to simulation of surges in such complex areas as bays and estuaries partly sheltered by barrier reefs, low-lying barrier islands, which might be overtopped at some stage during the surge, and inundated flood plains. It has been applied to design hurricane simulations in Biscayne Bay, Florida, and Darwin, Australia, among other locations. Both model stages are based on DHI's computer system "System 21" which computes the flows and water levels in a model of the area under study using a finite difference method for solution of the equations of continuity and momentum for nearly-horizontal two-dimensional flows. The area may be of quite arbitrary shape and bathymetry. References (6 items).

Farrell, I.M. The Current Essentials of Dispersion and Diffusion. First Australian Conference on Coastal Engineering, Sydney, May 14-17, 1975; Engineering Dynamics of the Coastal Zone, p.151-158. (See annotation in Section I.)

Grabert, A., and Malherbe, J.-F. Evaluation de la capacité de réfrigération d'un estuaire. Exemple de la Loire. (Calculating the Cooling Capacity of an Estuary. Example of the Loire Estuary). LA HOUILLE BLANCHE, vol.29, No 1/2, p.35-46, 1974. (In French.) See annotation in Section IV.)

Davidson, B. Process Control Model for Oxygen Regeneration of Polluted Rivers, Phase II. Water Resources Research Institute, Rutgers University, New Brunswick, N.J., April 1971.

A new parameter estimation procedure has been invented for the direct determination of the natural reaeration coefficient by frequency response analysis. By the use of a mechanical instrum

aerator device, which is operated in a periodic fashion with a variable amplitude, it is possible to determine quantitatively the value of the natural reaeration coefficient from field measurements of dissolved oxygen concentration. The method makes use of a detailed one-dimensional, unsteady-state Streeter-Phelps type model of a polluted river. Also, nonlinear optimal control theory has been applied to the distributed BOD problem in polluted rivers. The use of selected effluent dispersion patterns along a continuous stretch of a watercourse have a marked influence on residence time distribution patterns and the character of source and sink terms in the bio-system models. Enhanced assimilative capacities for polluted river segments have been demonstrated through the use of appropriate distribution policies derived theoretically for a semi-hypothetical river using nonlinear optimal control theory. Included in the control theory analyses are dual water quality standards and economic factors for pipeline distributors and waste treatment plants. (Whipple-Rutgers.) References (6 and 18 items)

Davidson, B. Process Control Model for Oxygen Regeneration of Polluted Rivers, Phases IV and V; and Spatially and Temporally Distributed Discharge of Effluents to Estuaries. Water Resources Research Institute, Rutgers University, New Brunswick, N.J., January 1974.

An unsteady-state, deterministic, 1-dimensional, nonisothermal, multistate variable, water quality model for the upper Delaware River Estuary system between Trenton, New Jersey, and Wilmington, Delaware, was developed, verified, and applied to several simulated systems analysis problems. The unique features of the proposed model are associated with its time and space scales, which are of the order of 30 min and 1 mi, respectively, and its simultaneous-state equation format, which included an ad hoc tidal velocity equation and conservation balances on DO, BOD, and thermal energy. Numerical routines using central differences for the space derivatives in combination with a 4th order, Runge-Kutta expression for the time derivatives provided stable and accurate results for the integration of the system equations. The capability of the proposed model was demonstrated by comparing the stationary-state, tidal-averaged simulated results with corresponding field data. Parameter sensitivity analysis and simulated shock-loading studies were made in addition to obtaining stationary-state results associated with simulated treatment plant regionalization plans.

Davidson, B., and Hunter, J.V. Process Control Model for Oxygen Regeneration of Polluted Streams (Phase I). Water Resources Research Institute, Rutgers University, Brunswick, N.J., Research Project Technical Completion Report, March 1970.

In the experimental part, the objective was to correlate rapidly determined parameters (i.e. chemical oxygen demand, organic carbon and ammonia) with 5-day BOD using linear regression analysis on samples taken from the Passaic River in New Jersey. Equations were developed for the prediction of the 5-day BOD 20C (dilution technique), the 5-day 20C BOD (Warburg technique), and the 20-day 20C BOD (Warburg technique) from the ammonia, organic carbon, and chemical oxygen demand concentrations. The resulting equations indicated that only somewhere between 40% and 80% of BOD variations were reflected by the concentrations of the parameters. In the theoretical part, the objective was to provide control models for simulating staged instream aerators based on experimental data taken from the Passaic River instream aeration project. The models were computerized on an analog computer for use in obtaining oxygen-uptake rates and parameter values. As part of the theoretical investigations, the optimal instream aeration problem was formulated and analyzed in terms of Pontryagin's Minimum Principle. (WRSIC abstract.) List of Publications (9 items).

Davidson, B., Vichnevetsky, R., and Wang, H.F. Numerical Techniques for Estimating Best-Distributed Manning's Roughness Coefficients for Open Estuarial River Systems. WATER RESOURCES RESEARCH, vol.14, No.5, p.777-789, Oct. Dec. 1978.

A finite difference version of the Levenberg-Marquardt method for nonlinear least squares problems has been extended to include inverse problems in distributed estuarial hydraulic systems. The objective in solving the inverse problems was to establish a numerical simulation procedure for estimating best-distributed Manning's roughness coefficients from sets of observed tide heights. As an illustration, spatially varying Manning's roughness coefficients for the Upper Delaware River Estuary system were determined for several representative sets of tide height data for the period October 1973 to June 1974. The roughness coefficients were modeled as polynomial functions of distance. Manning's n was thus found generally to vary inversely with distance from the head of tide at Trenton to Wilmington. The spatially distributed tidal-averaged Reynolds

number Re was used to correlate Manning's n and Darcy-Weisbach's f. The resultant n-Re relationships displayed three distinct hydrodynamic flow regimes characterized as having turbulence. Both n and f were found to be independent of Re for $Re > 1.52 * 10^6$ but inversely related to Re for $Re < 1.2 * 10^6$. Among the numerical techniques used to simulate tidal hydraulic transients it was found that a 'hopscotch' finite difference method yielded the best compromise between computational economy and overall accuracy. References (65 items).

Dazzi, R., and Tamasino, M. Mathematical Model of Salinity Intrusion in the Delta of the Po River. Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, Copenhagen, Denmark, vol.III, 1975, Chapter 134 (p.2302-2321). (See annotation in Section III.)

Dazzi, R., and Tomasino, M. Salt Wedge: Which Schemes? Proceedings, XVIth Congress of the International Association for Hydraulic Research, São Paulo, Brazil, July 27 to August 1, 1975, vol.3, Paper C34. (See annotation in Section III.)

De Guida, R., Connor, J.J., and Pearce, B. Application of Estimation Theory to Design of Sampling Programs for Verification of Coastal Dispersion Predictions. Massachusetts Institute of Technology, Sea Grant Program Report No.MITSG 76-16, November 20, 1976. (See annotation in Section I.)

Dinelli, G., and Castellano, L. Design Model for Thermal Effluents in Rivers. Journal of the Hydraulics Division, ASCE, vol.105, No.HY3, p.197-211, March 1979.

A quasi three-dimensional mathematical model describing the thermal impact of warm water discharges in rivers is presented. The governing equations are obtained integrating along the depth the complete set of the Navier-Stokes equations with Leibniz's rule and assuming that buoyancy forces are negligible. After the analytical integration is performed, in the mass momentum and energy equations, terms appear that make it possible to account for the effects of the actual geometry of the river's cross section and bottom. The eddy viscosity and thermal diffusivity are taken into account by adopting an algebraic model of turbulence based upon the Prandtl mixing length theory. The numerical model, obtained with a finite difference method, provides the spatial time-dependent distributions of the velocity and temperature fields. The model's results have been satisfactorily checked against field data in the case of thermal discharges into fast moving rivers. References (20 items).

Downing, A.L. Forecasting the Effects of Polluting Discharges on Natural Waters -- I. Rivers. INTERNATIONAL JOURNAL OF ENVIRONMENTAL STUDIES, vol.2, No.2, p.101-110, 1971. (See annotation in Section IV.)

Downing, A.L. Forecasting the Effects of Polluting Discharges on Natural Waters -- II. Estuaries and Coastal Waters. INTERNATIONAL JOURNAL OF ENVIRONMENTAL STUDIES, vol.2, No.3, p.221-226, November 1971. (See annotation in Section IV.)

Drapeau, G., Harrison, W., Pien, W., et al. Oil Slick Fate in a Region of Strong Tidal Currents. Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, Copenhagen, Denmark, vol.III, 1975, Chapter 130 (p.2245-2259). (See annotation in Section IV.)

Dronkers, J.J., and Venis, W.A. Hydraulic and Soil-Mechanical Aspects of Enclosures in Estuaries. Transactions, Eleventh International Congress on Large Dams, Madrid, Spain, 11-15 June 1973, vol.II, Question No.41, p.1421-1438, Report 75 (See annotation in Section V.)

Edzwald, J.K., and O'Melia, C.R. Clay Distributions in Recent Estuarine Sediments. CLAYS AND CLAY MINERALS, vol.23, No.1, p.39-44, 1975. (See annotation in Section II.)

Elliott, A.J. Methods for Determining the Concentrations and Sources of Pollutants in Estuaries. Chesapeake Bay Institute, The Johns Hopkins University, Special Report 50, Reference 76-3, April 1976.

The application of kinematic box models to problems concerning the release of a passive contaminant into an estuary can give valuable predictions of the resulting concentrations. While having the advantages of being simple in principle and requiring minimal computer time, such models have the added proven advantage of giving reasonable and realistic results. One of the most useful methods considers

a partially-mixed estuary as being stratified vertically into two distinct layers and leads to predictions of the mean concentrations within each layer. Although normally used to predict the concentrations arising from a specified discharge, the method can also be used to determine the sources and sinks of a tracer if the concentrations are determined by measurement. This report documents two models which are capable of being used in either of these two ways, and includes full program listings as well as directions for their use. By considering the distribution of nutrients within the Upper Chesapeake Bay, it is shown how the results from the models may aid in understanding the nutrient balance which exists within the water column. References (4 items).

Elliott, A.J. A Numerical Model of the Internal Circulation in a Branching Tidal Estuary. Chesapeake Bay Institute, The Johns Hopkins University, Special Report 54, Reference 76-7, June 1976.

A numerical model has been developed which can be applied to a branching tidal estuary consisting of a major and tributary estuary; the model is applied to the combined system of the Chesapeake Bay and Potomac River. The branching model has the advantage of moving the open seaward boundary away from the region of interest (the Potomac) and at the same time it permits an investigation into the coupling of the Potomac with the circulation in Chesapeake Bay. Most of the numerical tests were made using constant values for the eddy diffusivities, and it was found that realistic stratification could not be obtained in this manner. Therefore, the vertical exchange coefficients were made depth and time dependent in a manner which related them to the bulk Richardson number. The preliminary tests have shown that the schematization of the bottom topography may influence the computed results. References (41 items).

Elliott, A.J. A Steady State Two-Layered Non-coupled Dynamic and Kinematic Estuarine Model with Application to the Potomac Estuary. Chesapeake Bay Institute, The Johns Hopkins University, Special Report 44, Reference 75-6, July 1975.

During the Spring of 1974 there was intensive biological sampling of the Potomac estuary timed to coincide with the spawning of the striped bass population. Concurrent with the biological program, a series of physical measurements were undertaken to provide hydrodynamical input to the biological investigation. These physical measurements took the form of a series of slack runs along the axis of the Potomac estuary at monthly intervals during the Spring of 1974. At each transect, lateral temperature and salinity data were taken at three stations which were approximately equally spaced across the estuary. The data were taken to obtain information on cross-channel density gradients which were used in dynamic calculations to estimate the character of the estuarine circulation. A previous model, which had been used to estimate concentrations in the estuary resulting from a unit source of pollutant, did not contain horizontal diffusion explicitly. As a result of the dynamic calculations, it was possible to formulate a model which did include both horizontal and vertical diffusion. This model was used with field data to estimate circulation and mixing characteristics during part of the 1974 spawning season. The advantage of the present model is that it treats horizontal and vertical diffusion explicitly and may, therefore, be more relevant to biological models used to predict the transport of fish eggs and larvae. References (10 items).

Elliott, A.J., and Wang, D.-P. The Effect of Meteorological Forcing on the Chesapeake Bay: The Coupling Between an Estuarine System and Its Adjacent Coastal Waters. Hydrodynamics of Estuaries and Fjords; Proceedings of the 9th Liege Colloquium on Ocean Hydrodynamics, 1977, p.127-145. (See annotation in Section I.)

Elliott, B.A., and Reid, R.O. Salinity Induced Horizontal Estuarine Circulation. Journal of the Waterways, Harbors and Coastal Engineering Division, Proc. ASCE, vol.102, No.WW4, p.425-442, November 1976. (See annotation in Section I.)

El-Sabh, M.I. Transport and Currents in the Gulf of St. Lawrence. Bedford Institute of Oceanography, Dartmouth, Nova Scotia, Canada, Report Series BI-R-75-9, July 1975. (See annotation in Section I.)

Emmett, W.W., and Thomas, W.A. Scour and Deposition in Lower Granite Reservoir, Snake and Clearwater Rivers near Lewiston, Idaho, U.S.A. JOURNAL OF HYDRAULIC RESEARCH, vol.16, No.4, p.327-345, 1978. (See annotation in Section II.)

Eriksson, E., and Peippo, J. En modell över vatten- och fosforomsättning i

Göteborgs skärgard. VATTEN, vol.31, No.2, p.106-119, 1975. (In Swedish.)

A simple compartment model of a typical estuary, the River Goeta Aelv, Sweden, and adjacent coastal areas, is presented, based on data on salinity distribution and river discharge and supported by actual observations of area currents. The fluxes of water between compartments are computed on the basis of conservation of water and salinity. The fate of P added to the river can be studied when the fluxes are used with average total P concentrations and known land sources of P. A large amount of P is precipitated when fresh water with suspended clay mixes with seawater. If precipitated amounts are assumed to be proportional to concentrations, simulation of the P status in the water can be made at various alternatives of treated sewage water disposal in the river. Estuaries are important sink areas for P, not only in muddy fresh waters but also for P in ocean waters mixing with fresh water in estuaries.

Fang, C.S., Parker, G., and Harrison, W. Hydrothermal Monitoring: Surry Nuclear Power Plant. Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, Copenhagen, Denmark, vol.III, 1975, Chapter 143 (p.2431-2450). (See annotation in Section VII.)

Farmer, D.M. The Influence of Wind on the Surface Layer of a Stratified Inlet: Part II. Analysis. JOURNAL OF PHYSICAL OCEANOGRAPHY, vol.6, No.6, p.941-952, November 1976.

Analysis of the wind and current data for Alberni Inlet demonstrates the strongly wind-dependent nature of the surface currents, especially at the diurnal frequency. In contrast, the response of the surface layer thickness is mainly restricted to lower than diurnal frequencies. A linear two-layer model with allowance for friction is used to show that frictional damping can account for the poor coupling at high frequencies. In fact the friction is sufficiently large to cause free modes to be critically damped (i.e., nonoscillatory). The model results compare favorably with the observations, using a frictional coefficient estimated from the decay of the internal tide. References (6 items).

Farmer, D., and Smith, J.D. Nonlinear Internal Waves in a Fjord. Hydrodynamics of Estuaries and Fjords; Proceedings of the 9th Liege Colloquium on Ocean Hydrodynamics, 1977, p.465-493. (See annotation in Section I.)

Farraday, R.V., O'Connor, B.A., and Smith, I.M. Galerkin Finite Element Solutions for Pollution Problems in Partially Mixed Estuaries. Paper presented at the International Symposium on Finite Element Methods in Flow Problems, edited by J.T. Oden, O.C. Zienkiewicz, R.H. Gallagher, and C. Taylor, The University of Alabama at Huntsville, 1974, p.399-400.

This abstract describes the application of a Galerkin finite element (G.F.E.) approach to the problem of predicting pollutant concentrations in partially mixed estuaries, such as that of the River Tees in the U.K. This estuary is approximately 40 km long, is relatively narrow and has a maximum width of 700 m. Mean depths vary from 4 m at the estuary head to 15 m at the sea face. Vertical stratification is pronounced on most tides (mean range 3.5 m) and intertidal variations occur in pollutant inflows. Consequently, any prediction method must take into account both of these factors. A G.F.E. solution was obtained for the two dimensional (longitudinal and vertical) diffusion-convection equation.

Farraday, R.V., O'Connor, B.A., and Smith, I.M. A Two-Dimensional Finite Element Model for Partially Mixed Estuaries. Proceedings, XVIth Congress of the International Association for Hydraulic Research, São Paulo, Brazil, July 27 to August 1, 1975, vol.3, Paper C31.

The paper describes a mathematical model which enables the longitudinal distribution of dissolved constituents to be described in partially mixed estuaries. The model operates on a real time basis and consists of a Galerkin-Finite Element solution to a laterally integrated two dimensional diffusion-advection equation. In its present form the model requires that the velocity field be predetermined from either field or physical model investigations. The mathematical model has been applied to the Tees Estuary (UK) and successfully used to reproduce measured salinity data. The need for a two dimensional approach to modeling partially mixed estuaries is demonstrated by comparing one and two dimensional model results for a given pollutant discharge situation. References (4 items).

Ferrari, F. Considerations on the Stability of a Tidal Lagoon Under Conditions of Inflow and/or Outflow of a Thermoelectric Power Plant-Cooling Water Circuit. Proceedings, XVIth Congress of the

International Association for Hydraulic Research, São Paulo, Brazil, July 27 to August 1, 1975, vol.1, Paper A10.

The purpose of this study consists in determining the possible effects on a natural lagoon directly connected to the sea, of inflow and/or outflow, required for feeding the cooling water circuit of a thermoelectric power plant. Tides and waves are taken into consideration in order to estimate the natural stability of the channel providing access to the lagoon and of the lines of dunes separating it from the sea. Once the conditions of natural equilibrium in the lagoon as a whole have been determined by a fairly simplified mathematical model, an examination is performed of the flow rates and of the shear stress values in the channel connecting the lagoon to the sea, under natural conditions, and then of the values which the same parameters would feature with an outflow rate or with an inflow rate of 80 cu.m./sec. in the lagoon. References (7 items).

Festa, J.F., and Hansen, D.V. A Two-Dimensional Numerical Model of Estuarine Circulation: The Effects of Altering Depth and River Discharge. ESTUARINE AND COASTAL MARINE SCIENCE, vol.4, No.3, p.309-323, May 1976.

Steady-state numerical solutions are obtained for a two-dimensional, vertically stratified model of a partially mixed estuary. The boundary at the seaward end of the estuary is considered to be open, with the profiles of salinity, vorticity and stream function obtained by extrapolating interior dynamics out to the boundary. A salinity source is maintained at the bottom of the mouth. Zero salt flux is required at a free-slip top and no-slip bottom boundary. Zero salinity and a parabolic velocity profile are maintained at the head of the esutary. A number of cases are run for various estuarine parameters; the river transport and Rayleigh number being the two parameters that have the most pronounced effect. The river transport is varied by adjusting the mean freshwater velocity, U_f. Decreasing U_f allows salt as well as the stagnation or null point to penetrate upstream. The estuarine circulation weakens, but expands over a larger portion of the estuary. The position of the stagnation point, with respect to the seaward boundary, varies as $U_f^{-5/8}$ for $U_f > 1$ cm/s and as $U_f^{-5/6}$ for $U_f < 1$ cm/s. Increasing the Rayleigh number, by deepening the estuarine channel, H, results in an increased circulation as well as strong intrusion of salinity and inward migration of the stagnation point. The horizontal location of the stagnation point is found to be proportional to Ra and therefore, varies as H^3 References (14 items).

Fischer, H.B. The Effect of Estuarine Circulation on Pollution Dispersal. U. S. Environmental Protection Agency, Office of Water Planning and Standards, Estuarine Pollution Control and Assessment, Proceedings of a Conference, vol.II, p.477-485, March 1977. (See annotation in Section I.)

Fischer, H.B. Mixing and Dispersion in Estuaries. In: Annual Review of Fluid Mechanics, edited by Milton Van Dyke, W.G. Vincenti, and J.V. Wehausen, vol.8, p.107-133, 1976. (See annotation in Section I.)

Fischer, H.B. Numerical Modelling of Dispersion in Estuaries. Proceedings of the International Symposium on Discharge of Sewage from Sea Outfalls, held in London August 27 - September 2, 1974, Paper No.37 (p.371-380); Edited by A.L.H. Gameson, Water Research Centre, U.K., Pergamon Press, 1975.

The paper discusses the use of simplified numerical models to predict the dispersion of pollutants in estuaries and, by extension, in coastal areas. No single model will be optimal for all problems. The first step in analyzing a dispersion problem is to determine the important mechanisms, primarily to decide which may be omitted from a computer model. The second step is to select from the variety of models now available that which is most appropriate to the problem at hand. This paper has described one model which is particularly efficient for uniform reaches of tidal rivers, and along uniform coastal areas; reference has been given to other models useful for other problems. Some general, although far from complete, suggestions have been given for the selection of the most efficient model. It remains nevertheless a matter of judgement and experience to select the most efficient model for any given problem, and to be aware of its limitations. References (25 items).

Fischer, H.B. Some Remarks on Computer Modeling of Coastal Waters. Journal of the Waterways, Harbors and Coastal Engineering Division, Proc. ASCE, vol.102, No.WW4, p.395-406, November 1976.

Limitations on ability of numerical models to model flow and dispersion of pollutants in coastal areas due to fundamental limitations in knowledge of exchange coefficients are covered. Specific limitations result from effects of stratification on control of flow and mixing rates, and from lack of understanding of the transverse exchange process. Examples of specific computer models are given, with emphasis on why some models give reliable results despite the limitations previously mentioned. References (29 items).

Fischer, H.B., and Dudley, E. Salinity Intrusion Mechanisms in San Francisco Bay, California. Proceedings, XVIth Congress of the International Association for Hydraulic Research, São Paulo, Brazil, July 27 to August 1, 1975, vol.1, Paper A16. (See annotation in Section III.)

Flügge, G., and Schwarze, H. Similarity Conditions for Thermal-Hydraulic Model Tests of Tidal Estuaries. Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, Copenhagen, Denmark, vol.III, 1975, Chapter 142 (p.2421-2430).

In connection with the design of proposed nuclear power plants on the Lower Weser River and on the Lower Elbe River in Germany, tidal models were constructed and tests carried out at the Franzius-Institute of the Technical University of Hannover for the purpose of studying the mixing and spreading of the hot water discharge. Thermal-hydraulic models are today still the most reliable method for the prediction of temperature distributions in the total area of temperature increase, especially in tidal regions.

Forrester, W.D., and El-Sabh, M.I. Principle of Salt Continuity Applied to Estuarine Transport Calculations. Proceedings, Symposium, Physical Processes Responsible for Dispersal of Pollutants in the Sea, with Special Reference to the Near-Shore Zone; held in Arhus, Denmark, 4-7 July 1972, p.49-52. Copenhagen, Denmark, December 1974. (See annotation in Section I.)

Frenette, M., Ouellet, Y., Poiré, A., et al. Principle of Management of Degenerated Inlets and Estuaries. Symposium on Modeling Techniques, 2nd Annual Symposium of the Waterways, Harbors and Coastal Engineering Division of ASCE, San Francisco, California, September 3-5, 1975, vol.I, p.315-334.

Efficient and proper utilization of inlets and estuaries requires a good knowledge of the evolution of the physical, hydraulic, sedimentological and biological components. Very often, a management can serve a cause to the detriment of another one. Research on scale model has been undertaken in order to define some principles of solutions for the management of degenerated inlets and estuaries so that a channel could be created without bringing too many changes to the other aspects of the inlets or estuaries. The model itself represents a river interconnected with a maritime basin by means of an estuary. Fluvial hydrogram, sediment histogram, bed morphology, tide, salt-water and freshwater, coastal current and waves, as well as different techniques of management, have been simulated in the model. References (13 items).

Fukuoka, S. An analytical and Experimental Study on Longitudinal Dispersion in an Idealized Estuary Flow. Fifth Australasian Conference on Hydraulics and Fluid Mechanics, University of Canterbury, Christchurch, New Zealand, 9-13 December 1974; Conference Proceedings, vol.II, p.268-275.

An analytical expression of the longitudinal dispersion coefficient for a turbulent alternating flow which may represent an idealized estuary flow was obtained on the basis of Aris's moment method. A main mechanism of longitudinal dispersion in estuary flows was assumed to be the combined effects of vertical shear and vertical turbulent mixing which is called the "shear effect." To gain the understanding of kinematics of turbulent alternating flows and to check the applicability of the theory a set of dispersion experiments was carried out in a laboratory flume. Velocity profiles for turbulent alternating flow in an open channel were found to obey approximately the power law relationship at each instant. The theoretical results were compared with experimental values of the longitudinal dispersion coefficient for turbulent alternating flow in both open channel and circular pipe. The dispersion experiments proved the validity of the theory. References (11 items).

Gade, H.G., and Svendsen, E. Properties of the Robert R. Long Model of Estuarine Circulation in Fjords. Hydrodynamics of Estuaries and Fjords; Proceedings of the 9th Liege Colloquium on Ocean Hydrodynamics, 1977, p.423-437.

It is shown that the circulation model proposed by Long implies that the brackish water thickness is completely

determined by the interfacial Froude number, the drag ratio and the density difference across the interface. Near the head this relationship approaches $h^2 \times \Delta\rho$ = constant . Numerical solutions to the set of differential equations are established to show the behaviour of the flow of the brackish layer. The solutions are illustrated in terms of integral curves referring to selected values of layer thickness, initial interfacial Froude number, drag ratio and growth factor of the width. References (8 items).

Galloway, F.M., Jr. Criteria for the Use of Vertical Averaging in Environmental Dispersion Models. WATER RESOURCES RESEARCH, vol.12, No.5, p.933-940, October 1976.

Vertical averaging, or averaging in a plane perpendicular to the mean flow, in environmental dispersion problems is desirable from the standpoint of the efficiency of computer solution. This paper presents a method based on computer solution of a model transport problem for estimating when cross-plane averaging is appropriate. The method is applied to four examples representing typical lakes, rivers, estuaries, and the atmosphere, respectively. The results are correlated in terms of a characteristic length, velocity and turbulent diffusivity, and two dimensionless parameters that depend on the velocity and vertical diffusivity profiles. It is shown that these parameters vary over a relatively small range for the variety of examples that are considered. References (16 items).

Gerges, M.A. Analogy in the Oceanographic Processes in the Mediterranean Sea and Estuaries. In: Processus de formation des eaux océaniques profondes en particulier en Méditerranée occidentale, Paris 4-7 Octobre 1972. Colloques Internationaux du Centre National de la Recherche Scientifique, No.215, p.147-154, 1974. (In English.)

Studying the general circulation of the Mediterranean Sea, the process of water exchange through the straits of Gibraltar and the water balance in the N.E. Atlantic and the Mediterranean basin, attention was given to the existence of the two-layer system of circulation in the basin of the Mediterranean Sea as a whole. The analogy between the oceanographic processes in the Mediterranean and in estuaries is discussed. The Atlantic Ocean with its less saline water, relative to the waters of the Mediterranean, and with a precipitation rate exceeding evaporation, is found to be analogous to the permanent source of fresh water in the case of estuaries. Using data collected during several expeditions in the Mediterranean Sea and analyzing the sections and profiles obtained in the different Mediterranean basins, it is shown that the features of an estuarine system exist. On this basis a model analogy is suggested for studying the Mediterranean regime of circulation as an estuarine process occurring on an oceanic scale. The model could be applied as well to the Red Sea with the Gulf of Aden as the source of fresh water. Literature (16 items).

Giese, E. Stability Problems for the Navigation Channel in a Tidal River. In: Rivers '76; Symposium on Inland Waterways for Navigation, Flood Control and Water Diversions; 3rd Annual Symposium of the Waterways, Harbors and Coastal Engineering Division of ASCE, Colorado State University, Fort Collins, August 10-12, 1976, vol.I, p.280-295, 1976.

The paper presents some of the work performed during the past number of years with a physical mobile bed model of the Elbe-estuary. After some basic information about model design, scales, model bed material, instrumentation and earlier tests, new results with regard to stability problems of the navigation channel are discussed in detail. Model scale ratios are 1:800 horizontally and 1:100 vertically. References (11 items).

Giese, E., and Vollmers, H. On the Reproduction of Morphological Changes in a Coastal Model with Movable Bed. Proceedings, XVIth Congress of the International Association for Hydraulic Research, São Paulo, Brazil, July 27 to August 1, 1975, vol.1, Paper A8.

The Bundesanstalt für Wasserbau (BAW) has been continuously developing technology for models with movable bed. Previous investigations are mostly related to the deepening of navigation channels and their stabilization effects under the influence of training constructions, and dredging and dumping areas. Thereby model transport processes could be investigated for locally limited regions with the help of radioactive tracers. New research work also includes observation of the stability of tidal flats. In a practical sense, what is desired is the prediction of gully system modifications, e.g. if existing tidal basins will be changed by new constructions. Such changes could involve retrogressive erosion initiating an undesired mass

transport into deeper channels. The development and stability of tidal basins could be demonstrated for both field and model in a similar fashion as has been done for deeper channels. Fundamental relations and mathematical procedures will be reported upon. References (4 items).

Giese, E., Harten, H., and Vollmers, H. Experience with Movable Bed Tidal Models. Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, Copenhagen, Denmark, vol.II, 1975, Chapter 61 (p.1051-1068).

The investigations involved morphological changes in areas with navigation channels, training structures, dumping places for dredged material, changes of water levels in connection with deepened channels, new high water dikes and influence of storm tides for models a) through d) and a damming up for model e) with regard to scour protection up- and downstream of weir reach. References (8 items).

Goodwin, C.R. Estuarine Tidal Hydraulics: One Dimensional Model and Predictive Algorithm. Ph.D. Thesis, Oregon State University, June 1974.

A one-dimensional, implicit, finite-difference model is developed, calibrated and verified for three estuaries along the central Oregon coast. The model is used to generate controlled data for a large number of hypothetical estuaries. Two nondimensional coefficients, K_F and K_I, are developed incorporating physical characteristics of the estuary which summarize the effects due to friction and inertia, respectively. These coefficients are used to explain the variability of tidal response throughout the complete range of hypothetical estuaries investigated. A predictive algorithm based on the derived relationships is presented and examples of its application to real estuaries is given. The results of this study can be used to predict modifications in tidal response due to proposed physical changes in an estuary, such as entrance dredging or filling of tidal flats. Field data of velocity, temperature and salinity for the Yaquina, Alsea and Siletz estuaries are included with the paper. Bibliography (64 items).

Gordon, R., and Spaulding, M. A Bibliography of Numerical Models for Tidal Rivers, Estuaries and Coastal Waters. University of Rhode Island, Marine Technical Report 32; Ocean Engineering, NOAA Sea Grant, 1974.

The document catalogs literature available in the field of numerical modeling for tidal rivers, estuaries, and coastal waters. Included models are of both a deterministic and statistical nature. The deterministic models in this classification use such forcing functions as tidal height, wind stress, density gradients, etc., in determining the velocity field. A limited number of models have been included which do not fit this description. The publication includes a document listing, a selected review and four indices: (a) keyword-in-context (KWIC) index, (b) author index, (c) corporate index, and (d) inverted index.

Great Britain. Hydraulics Research Station, Wallingford. The Wash Water Storage Scheme; Numerical Model Studies of the Great Ouse Estuary: A Mixing Length Function for Vertical Exchange in Turbulent Stratified Two-Layer Flow. Report No.DE 11, January 1974.

A theoretical expression was derived for the vertical exchange of momentum and solute in turbulent stratified shearing two-layer flow, based on Prandtl, Kent, Pritchard and Ellison's mixing theories. Field observations were made in a straight canalised reach of the Great Ouse Estuary to evaluate empirical coefficients in the relationship between the interfacial mixing length and a Richardson number. The proposed function, which will be incorporated into a numerical model of the estuary, is applicable to conditions when the Richardson number is less than 2. The field observations were consistent with results derived from laboratory experiments made by Moore and Long. References (17 items).

Great Britain, Water Research Centre, Stevenage Laboratory. One-Dimensional Models of Estuarine Pollution. Notes on Water Pollution No.69, June 1975. (See annotation in Section IV.)

Greenberg, D.A. Mathematical Studies of Tidal Behaviour in the Bay of Fundy. Marine Sciences Directorate, Department of Fisheries and the Environment, Ottawa, Manuscript Report Series No.46, 1977.

The presence of extraordinarily high tides in the Bay of Fundy has led to interest in the possibility of establishing tidal power schemes there. In this thesis, a numerical tidal model has been set up to test the effects of tidal barrier

schemes installed in the upper reaches of the bay. To model a large area in which fine definition was needed in some parts (in this case, upper Fundy), but not in others, it was necessary to develop a method of using finite difference grids of differing sizes integrally incorporated in one numerical model. The mesh refinement technique was used to formulate a model of the Bay of Fundy and the Gulf of Main using three different sizes of finite difference grid. Permeable barriers were representative of those used in ebb-flow power generation. Significant changes in the M_2 tidal regime in the Gulf of Main were found for some barrier configurations. References (27 items).

Grenney, W.J., Procella, D.B., and Cleave, M.L. Water Quality Relationships to Flow -- Streams and Estuaries. In: Methodologies for the Determination of Stream Resource Flow Requirements: An Assessment, edited by C.B. Stalnaker and J.L. Arnette; Utah State University, Logan, 1976, p.35-88.

Methodologies for evaluating water quality in streams and estuaries in relation to flow changes are examined. All of these methodologies are essentially either direct measurements or models. We first define terms relating to: 1) Evaluation of instream flow effects on water quality based on actual measurements of flow; and 2) simulation models and their application and relationship to flow requirements. References Cited (225 items).

Groen, P. A Simplified Theory of the Combined Effect of an Anti-estuarine Circulation and a Superimposed Counteracting Wind Drift. From Koninkliske Nederlandse Akad. Vau. Weterschappen, Series B, vol.74, No.4, p.358-364, 1971. (In English.) (See annotation in Section I.)

Grubert, J.P. Numerical Computation of Two-Dimensional Flows. Journal of the Waterways, Harbors and Coastal Engineering Division, Proc. ASCE, vol.102, No.WW1, p.1-12, February 1976.

A computational system is presented for the calculation of long waves in harbors and coastal seas. The numerical method used is a three level implicit finite difference scheme, using the fractional steps technique. Tests on harbors under gale conditions with waves of one minute period, show that nonlinear instabilities develop, but they can be dissipated by iterating for equation coefficients. References (9 items).

Grubert, J.P. Numerical Computation of Well-Mixed Estuarine Flows. Journal of the Hyrdaulics Division, Proc. ASCE, vol.102, No.HY7, p.955-967, July 1976.

A numerical model is presented for the computation of flow variables in a well-mixed estuary. The numerical method used is an implicit unconditionally stable finite difference scheme, of second-order accuracy. Data are presented for the scheme in a physically realistic way, to avoid nonlinear instabilities, and for this purpose the dynamic equations are written in pentadiagonal form and solved with a generalized double-sweep algorithm. References (13 items).

Hacker, S. Transport Phenomena in Estuaries. Ph.D., Dissertation, Louisiana State University, August 1973. (See annotation in Section II.)

Hahn, H.H. and Klute, R. Pollutional Effects of Suspended Sedimented and Eroded Particulate Material in the Aqueous Environment. Proceedings of the International Conference on Environmental Sensing and Assessment, Las Vegas, Nevada, September 14-19, 1975, vol.1. (See annotation in Section IV.)

Halliwell, R., and O'Connor, B. Quantifying Spoil Disposal Practices. Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, Copenhagen, Denmark, vol.III, 1975, Chapter 153 (p.2581-2600). (See annotation in Section II.)

Hamilton, P. A Numerical Model of the Vertical Circulation of Tidal Estuaries and Its Application to the Rotterdam Waterway. Geophysical Journal of the Royal Astronomical Society, vol.40, p.1-21, 1975.

A two-dimensional numerical model has been developed to represent the vertical structure of current and salinity along an estuary of varying width and depth but with a rectangular cross-section. The governing equations, which express the conservation of volume, momentum and salt content, are solved by a finite difference initial-value method. The finite difference grid is arranged to cover the vertical profile of the estuary so that the free surface moves vertically through the grid points. Thus the surface elevation and the profiles of current and salinity are determined throughout the tidal period as the equations are integrated stepwise through time. The model has been applied to the Rotterdam

Waterway and the resulting distributions have been compared with field data from surveys by the Rijkswaterstaat of the Netherlands, made available for this study by the late Dr. J.J. Dronkers. Reasonable agreement has been obtained and to this extent the ability of the model to reproduce the general features of estuarine circulation has been established. References (30 items).

Hamilton, P. On the Numerical Formulation of a Time Dependent Multi-Level Model of an Estuary, with Particular Reference to Boundary Conditions. Estuarine Processes; Volume II, Circulation, Sediments, and Transfer of Material in the Estuary, edited by Martin Wiley. New York, Academic Press, 1977, p.347-364.

A two dimensional model of the vertical circulation of an estuary has been developed, which solves, by an explicit finite difference initial value method, the equations of continuity, salt and momentum conservation for a channel of variable width and depth, but rectangular cross section. A further semi-implicit extension of the model is given, which removes the dependency of the time step on the depth and makes feasible long integration periods. Features of the model include a finite difference grid which allows the tidally driven free surface to move vertically through the grid points, along with accurate finite difference formulations of the surface and bottom boundary conditions. If long periods of integration are considered, the effect on the salt balance of different formulations of the vertical eddy coefficients is shown to make the choice of the mouth boundary condition on salinity ambiguous. References (36 items).

Hann, R.W., Jr., and Young, P.J. Mathematical Models of Water Quality Parameters for Rivers and Estuaries. Texas A&M University, Water Resources Institute, Technical Report No.45, October 1972.

The development of computer models for mass transport in estuaries has been an important engineering activity for the past decade. However, only a limited amount of work has been done in modeling the two-dimensional characteristics of partially stratified estuaries. Explicit and Crank-Nicolson finite difference models were developed for the one-and two-dimensional estuary equations with varying coefficients. The concentration profiles for instantaneous releases and for steady-state conditions were analyzed. Accuracy was determined by comparison with analytical closed-form solutions. Models were developed also to analyze the profiles for biochemical oxygen demand and dissolved oxygen under time-changing conditions, for both aerobic and anaerobic conditions. Applicability of these models to partially stratified estuaries was established by comparisons with dye study data from the Houston Ship Channel. (Author Modified Abstract.) References (110 items).

Hansen, D.V., and Festa, J.F. Inlet Circulation Induced by Mixing of Stratified Water Masses. Proceedings, Symposium, Physical Processes Responsible for Dispersal of Pollutants in the Sea, with Special Reference to the Near-Shore Zone, held in Arhus, Denmark, 4-7 July 1972, p.163-170. Copenhagen, Denmark, December 1974.

Functional and numerical models have been developed to describe a three-layered circulation induced by mixing of stratified water masses in estuarine embayments having negligible fresh water inflow. The flow is into the inlet at the surface and along the bottom, and outward at middle depths. The characteristic salinity distribution has the conventional positive seaward gradient in the lower portion of the inlet, but a negative seaward gradient nearer the surface. The regime is characterized by five dimensionless parameters: an estuarine Rayleigh number, a turbulence Prandtl number, the aspect ratio, the ratio of horizontal mixing time scale to vertical mixing time scale, and bottom friction. The strength of the circulation is increased by increasing vertical Austausch, and is decreased by increasing horizontal Austausch. References (9 items).

Hard, C.G. Aspects of Dredged Material Research in New England. In: Estuarine Research, Volume II: Geology and Engineering, edited by L. Eugene Cronin, Academic Press, Inc., New York, 1975, p.537-540. (See annotation in Section II.)

Harden, T.O., and Shen, H.T. Numerical Simulation of Mixing in Natural Rivers. Journal of the Hydraulics Division, ASCE, vol.105, No.HY4, p.393-408, April 1979. (See annotation in Section IV.)

Harder, J.A. Predicting Estuarine Salinity from River Inflows. Journal of the Hydraulics Division, Proc. ASCE, vol.103, No.HY8, p.877-888, August 1977.

An analysis system is described that enables the second-order and higher nonlinear interactive effects to be estimated

in the relationship between the input and output of nonlinear systems. No data are, in principle, required other than an input and output time history over a sufficient period. The method is compared with the functional approach of Weiner and shown to have advantages in practical application. An application to the prediction of salinity in estuaries from river inflows is described. An error analysis for the prediction of salinity at Benicia, Calif., shows that systematic errors in the data and the influence of unaccounted-for variables contribute the bulk of the error in making the predictions and that the error attributable to the analysis leading to the construction of the predictor contributes a smaller error, which is estimated to be on the order of 8% in this application. References (9 items).

Harleman, D.R.F., and Thatcher, M.L. Longitudinal Dispersion and Unsteady Salinity Intrusion in Estuaries. LA HOUILLE BLANCHE, vol.29, No.1/2, p.25-33, 1974. (In English.)

The objective of the paper is to review the difficulties in the development of mathematical models for salinity distribution and to present the results of a recent mathematical model developed for the prediction of one-dimensional, unsteady salinity intrusion in variable area estuaries. (From Paper.) References (16 items). With discussion.

Harten, H. Model Trials with Movable Bed Section for Improving the Main Navigational Channel of the Elbe River. Proceedings, XVIth Congress of the International Association for Hydraulic Research, São Paulo, Brazil, July 27 to August 1, 1975, vol.1, Paper A7.

Since conclusions about morphological changes on the basis of flow speed and current measurements in models with a fixed bed are encumbered with numerous factors of uncertainty, a sufficiently large partial section of the Elbe model with fixed bed was given a movable bed. The combination of fixed bed with a partial movable section in a tidal model is a new method producing much better results. The model was considered nature-similar when enough tides had been run so that the roughness of the originally flat movable section corresponded with that of the upper and lower fixed bed sections and the water level is in accord to nature. The model showed fillings in the navigation channel in the same areas as in nature. The larger scour areas, such as those near St. Margarethen, are also clearly visible. Thus good nature similarity was obtained based on both hydraulic data and morphological characteristics of the investigated region. References (5 items).

Harverson, D. Modelling Current Movements Within Bodies of Water. In Statistical and Mathematical Aspects of Pollution Problems, edited by John W. Pratt; Marcel Dekker, Inc., New York, 1974, Part III, Chapter 14 (p.213-220).

A type of model discussed is one which is designed to reproduce or predict the track of a single, rigid object, such as a drogue. The movement of this object is assumed to be entirely governed by the currents within a particular layer of water in the area with which the model is concerned. The depth of this layer is one of the parameters of the model. Others are the prevailing condition of wind and tide, and the point at which tracking is supposed to start. A model of this kind can form the basis for predicting a slick of oil or sewage, and can also be used to study the formation of such a slick by a process of continuous discharge. Such a model may be constructed using various techniques. Those which are described are appropriate when dealing with broad stretches of water, particularly tidal waters. For rivers and estuaries narrow enough for the flow in any layer to be virtually one-dimensional, a simpler approach is possible. References (5 items).

Hendrikse, M. The Effect of Resistance Bars upon an Arrested Salt Wedge. Submitted in Partial Fulfillment of the Requirements for the Degree of Master of Science at the Massachusetts Institute of Technology, September 1965.

This study was conducted in Delft Hydraulics Laboratory, Delft, The Netherlands, and submitted to the Department of Civil Engineering of the Massachusetts Institute of Technology on September 21, 1965, in partial fulfillment of the requirements for the degree of Master of Science. The increased resistance required in distorted hydraulic models can be obtained by placing vertical rods or strips in the flow. To reproduce a proper salinity distribution in an estuary model, vertical mixing caused by the rods has to be taken into account also. This study shows vertical rods to cause differences between the shape of an arrested saline wedge in non-distorted models and in distorted models. Similar conclusion holds for the slope of the water surface. The distortion caused by a given set of resistance bars was found to be different for different river discharges. Bars

were found to cause insignificant mixing and not to influence interfacial shear stress coefficient. References (13 items).

Herrmann, F.A., Jr. Movable-Bed Model Study of Galveston Bay Entrance. In: Estuarine Research, Volume II: Geology and Engineering, edited by L. Eugene Cronin, Academic Press, Inc., New York, 1975, p.93-110.

Paper presented at the Second International Estuarine Research Conference, held by the U. S. Estuarine Research Federation at Myrtle Beach, South Carolina, 15-17 October 1973. Tests were conducted to: (a) develop plans for relocation and stabilization of the jetty channel on an alignment and at a depth suitable for the safe passage of large tankers; (b) determine means for protecting the north jetty from the undermining action of tidal currents; (c) determine the shoaling characteristics of the relocated and deepened inner bar part of the jetty channel, and develop plans for minimizing shoaling in the relocated channel; (d) determine the shoaling characteristics of the deepened outer bar part of the jetty channel; and (e) determine the best locations for additional anchorage areas within the jetty channel or in Bolivar Roads. The movable-bed model was constructed to scale ratios of 1:500 horizontally and 1:100 vertically. Describes the model, model verification, postconstruction confirmation study, and model test results. References (2 items).

Herrmann, F.A., Jr. Overview of Physical Estuary Practice. Symposium on Modeling Techniques, 2nd Annual Symposium of the Waterways, Harbors and Coastal Engineering Division of ASCE, San Francisco, California, September 3-5, 1975, vol.II, p.1270-1290.

The paper presents a very brief discussion of similitude relations, selection of model scales, and scale effects for distorted-scale, fixed-bed physical models of estuaries. The problems susceptible to model analysis are enumerated. The advantages and disadvantages of employing physical models are discussed, including a cursory comparison with numerical models. The purpose and methods for model verification are discussed and verification test results are presented from several typical models. An emergency study in the Delaware River model to determine the rate of saltwater advancement up the estuary during the 1965 drought is described. A study of shoaling in Brunswick Harbor is also presented. The recommended improvement plan has been constructed in the field and data are presented for comparison with the model predictions. The cost savings effected by a dike rehabilitation study in the Delaware River model are also presented. References (8 items).

Hess, K.W. A Three-Dimensional Numerical Model of the Estuary Circulation and Salinity in Narragansett Bay. ESTUARINE AND COASTAL MARINE SCIENCE, vol.4, No.5, p.525-538, May 1976.

Gravitational circulation in an estuary is produced primarily by longitudinal density differences, but other factors, such as local topography, the Coriolis acceleration and lateral density variations may be equally important. A generalized three-dimensional rigid-lid model of the steady, density-driven flow is formulated herein, which includes spatial variations in depth, eddy viscosity and diffusivity and horizontal pressure gradients. An equation of steady salt conservation is also solved, including convection, based on the gravitation circulation and diffusion in the three directions. Some details of the numerical computations are presented and comparisons with observations from Narragansett Bay are evaluated. Cyclonic circulation predicted by the model is discussed as an example of its capabilities. References (17 items).

Hess, K.W., and White, F.M. Modeling the Dispersal of a Marked Fluid in Narragansett Bay. University of Rhode Island, Marine Technical Report No.38, 1975.

The report summarizes some of the work carried out at the University of Rhode Island in its Sea Grant program for estuarine modeling, and updates parts of the engineering effort in this discipline. Specifically, a numerical model of the convective-diffusive equation of mass conservation is developed for the most general applications, and is coupled with a previously developed tidal-hydrodynamic model of Narragansett Bay. The computer scheme is then applied to a practical problem, the simulation of the temporal and spatial dispersal of a marked fluid introduced into the Bay at a specific site. Thus an indication of the fate of a foreign substance, which might represent sewage or heated water, can be gained at low cost, and such information can be used in the public and private decision-making process. References Cited (11 items).

Hess, K.W., and White, F.M. A Numerical Tidal Model of Narragansett Bay. University of Rhode Island, Marine Technical Report No.20. 1974.

The basic approach of Leendertse was chosen for the development of the numerical model of Narragansett Bay, which is a wide, shallow estuarine system dominated by tidal effects. The model had been successfully applied to a small harbor by Grimsrud and has now been adapted to the Bay with several modifications. The report gives an explanation of the mathematics of the solution as used in the Bay model, along with certain necessary modifications of the original approach. The model was developed to provide information concerning the tidal dynamics of the Bay and the accompanying currents and flowrates. Verification studies were carried out and reported here, and the model will be used as the basis of a concentration-transport model for the study of salinity, temperature, and biochemical parameters in the Bay. References (32 items).

Hess, W.N., and Nelson, T.A. A Test Particle Dispersion Study in Massachusetts Bay. Seventh Annual Offshore Technology Conference, Houston, Texas, May 5-8, 1975; Proceedings, vol.I, Paper No. OTC 2160. (See annotation in Section VII.)

Higuchi, H., and Sugimoto, T. Experimental Study of Horizontal Diffusion Due to the Tidal Current. Proceedings, Symposium, Physical Processes Responsible for Dispersal of Pollutants in the Sea, with Special Reference to the Near-Shore Zone, held in Arhus, Denmark, 4-7 July 1972, p.177-184. Copenhagen, Denmark, December 1974.

Diffusion in the coastal area of south west Japan is considered with particular reference to the Seto Inland Sea. Large and small-scale hydraulic models are used to investigate the importance of the local circulation on rate of diffusion. References (4 items).

Higuchi, H., and Yanagi, T. Horizontal Diffusion in a Tidal Model. Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, Copenhagen, Denmark, vol.III, 1975, Chapter 139 (p.2377-2390).

The effect of the tidal residual flow on the horizontal diffusion in a shallow tidal bay is investigated through a hydraulic model experiment, for which Mikawa Bay in central Japan was used as a prototype. A hydraulic model of about 20 × 30 m including Mikawa Bay and neighboring sea area, with a horizontal and vertical scale of 1/2000 and 1/160, respectively, was used, and a semi-diurnal tide was provided for it. Experiments have shown that tide and tidal current are well reproduced in the model. The tidal locus does not close, that means the residual flow exists. The distribution of the concentration of the dye, which is discharged from the bay bottom, corresponds to the pattern of the residual flow. The diffusion coefficient in the bay obtained through one dimensional analysis is to the order of 10^5 cm^2/sec and that two dimensional analysis is less by one order and the dispersion coefficient becomes 10^5 cm^2/sec. It is concluded that the dispersion due to the residual flow plays a more important role on the distribution of the material in the shallow bay, as Mikawa Bay, than the diffusion due to the tidal current itself. References (2 items).

Higuchi, H., Fikuda, T., Ihara, H., et al. Experimental Studies of Tidal Flow and Diffusion in the Seto Inland Sea. Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, Copenhagen, Denmark, vol.III, 1975, Chapter 138 (p.2368-2376).

The paper describes the environmental problem of the Seto Inland Sea of Japan. A number of model studies of tidal flow and effluent diffusion of this sea are presented. In particular the similarity law that has been developed to model turbulent diffusion is delineated. References (3 items).

Higuchi, H., Sugimoto, T., Geshima, H., et al. Tidal Residual Circulations in the Hydraulic Model. Symposium on Modeling Techniques, 2nd Annual Symposium of the Wayerways, Harbors and Coastal Engineering Division of ASCE, San Francisco, California, September 3-5, 1975, vol.II, p.1042-1049.

The tidal residual circulation induced by the coastal boundary geometry of the bay is studied mainly by use of hydraulic model experiment. Theoretical suggestion that these circulations are formed by the rotation of the non-linear effect of the tidal currents is verified, and the process was made more clear. These circulations have great importance for local distributions of substances as well as water exchange of the bay. They are similarly reproduced in the model when the non-dimensional parameters, Froude number and Reynolds number, are made to

coincide between the model and the prototype. References (3 items).

Hinwood, J.B., and Wallis, I.G. Classification of Tidal Waters. Journal of the Hydraulics Division, Proc. ASCE, vol.101, No. HY10, p.1315-1331, October 1975. Discussion, vol.102, No.HY6, p.808-811, June 1976; Closure, vol.102, No.HY12, p.1776-1777, December 1976.

A classification scheme is presented for numerical models of water and waste movement in tidal bays and estuaries. This classification is based on the number of spatial dimensions, the reference frame used, temporal resolution obtainable and the degree to which hydrodynamic processes are included. Newly developed models can easily be fitted into the scheme. With this classification scheme, different models may be assessed and compared on the basis of their theoretical assumptions. To select a model for a particular task, a sequence of questions may be answered and from the answers the appropriate type of model may be selected. The classification table then indicates the models available to meet the requirements of the particular physical situation. References (141 items).

Hinwood, J.B., and Wallis, I.G. Modelling the Movement of Conservative Materials in Tidal Estuaries. First Australian Conference on Coastal Engineering, Sydney, May 14-17, 1973; Engineering Dynamics of the Coastal Zone, p.159-166.

This paper reviews the different approaches that have been made in modeling the transport of materials in tidal estuaries. The models are classified on the basis of the number of spatial dimensions, the reference frame used and the assumptions made to simplify the model. The advantages and limitations of present estuarine transport models are discussed. The selection of the appropriate model to assist in the examination of a given water quality problem and future research needs are outlined. References (83 items).

Hinwood, J.B., and Wallis, I.G. Review of Models of Tidal Waters. Journal of the Hydraulics Division, Proc. ASCE, vol.101, No.HY11, p.1405-1421, November 1975. Discussion, vol.102, No.HY6, p.808-811, June 1976; vol.102, No.HY8, p.1145-1148, August 1976, vol.103, No.HY1, p.89, January 1977; Closure, vol.103, No.HY4, p.453-455, April 1977.

Approximately 100 models of water and waste movement in tidal bays and estuaries have been reviewed and their predictive capability and limitations have been examined. The review provides the detailed analysis of different models within the same classification. By using this review in conjunction with the classification scheme and the sequence of selection questions given in Proc. Paper 11643, the most appropriate model for a particular task may be selected. References (164 items).

Hodgins, D.O., Osborn, T.R., and Quick, M.C. Numerical Model of Stratified Estuary Flows. Journal of the Waterway, Port, Coastal and Ocean Division, Proc. ASCE, vol.103, No.WW1, p.25-42, February 1977. Errata, vol.104, No.WW1, p.95-96, February 1978.

Salt-water intrusion in the Fraser River estuary was modeled numerically and compared with a field measurement program. The salt wedge was observed to have a highly dynamic behavior and yet to retain its stratified character. The main physical and computational problems studied were: (1) The interfacial stress term; (2) the necessary boundary conditions at the river mouth; and (3) the computational stability. References (14 items).

Horiguchi, T. Numerical Analysis of Waste Water Dispersion in Thermally-Stratified Layers. COASTAL ENGINEERING IN JAPAN, vol.16, p.187-200, 1973. (See annotation in Section IV.)

Horwood, J.W. Development and Implementation of an Integrated Hydrodynamical Mathematical Model of the Irish Sea. Fisheries Laboratory, Lowestoft, Suffolk, United Kingdom. Fisheries Laboratory Technical Report Series Number 9, May 1974. (See annotation in Section I.)

Horwood, J.W., and Bedwell, J.A. Results from a Hydrodynamical Mathematical Model of the Irish Sea. ECOLOGICAL MODELLING, vol.[illegible], No.[illegible], p.[illegible]-33[illegible], May 19[illegible]. (See annotation in Section VIII.)

Hosoda, K., Araki, T., and Kimizuka, A. The Tone Estuary Dam. Transactions, Eleventh International Congress on Large Dams, Madrid, Spain, 11-15 June 197[illegible], vol.II, Question No.[illegible], p.[illegible], Report 28.

Model tests were carried out to study the principles of dam operation and the hydraulic mechanism in order to correspond to the ever-changing nature [illegible]

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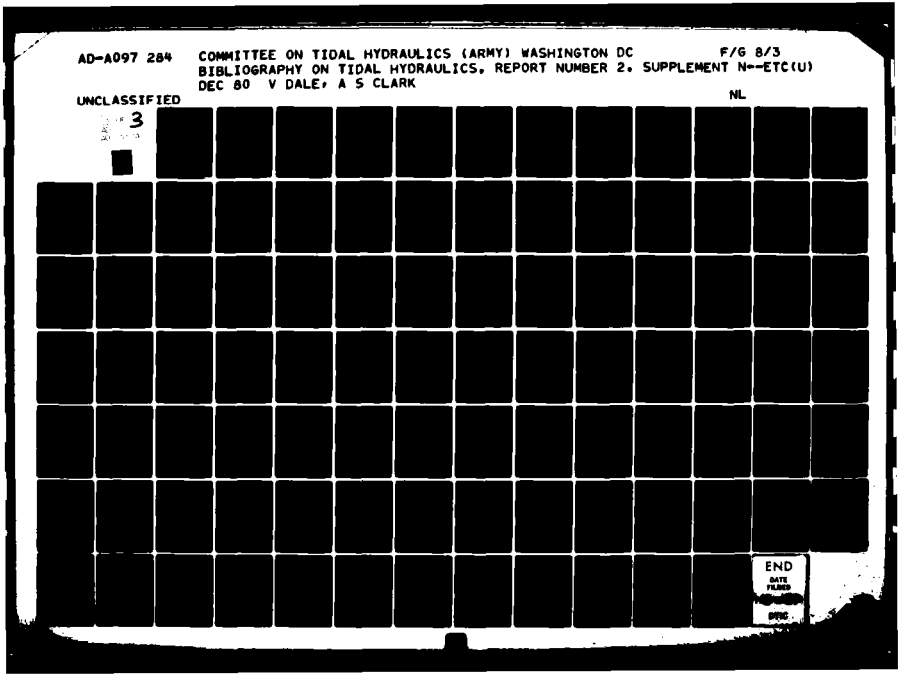

involving flow discharge, sea water level, etc., and to draw in service water and irrigation water with salt content lower than the allowable level while providing water of necessary salt content for marine resources upstream of the dam. The actual conditions of operation of the dam are introduced together with some data to report that the dam is fulfilling its mission in spite of the complicated natural conditions.

Howells, W.R., Owens, M., and Stoner, J.H. Water Quality Aspects of Welsh Estuarine and Coastal Waters. JOURNAL OF THE INSTITUTION OF WATER ENGINEERS AND SCIENTISTS, vol.32, No.5, p.365-390, September 1978. (See annotation in Section V.)

Hunter, J.R. The Determination of Current Velocities from Diffusion/Advection Processes in the Irish Sea. ESTUARINE AND COASTAL MARINE SCIENCE, vol.3, No.1, p.43-55, January 1975. (See annotation in Section I.)

Hunter, J.R. A Method of Velocity Field Interpolation Applicable to Stratified Estuaries. Chesapeake Bay Institute, The Johns Hopkins University, Special Report 45, Reference 75-7, August 1975. (See annotation in Section I.)

Hunter, J.R. A One-Dimensional Dynamic and Kinematic Numerical Model Suitable for Canals and Estuaries. Chesapeake Bay Institute, The Johns Hopkins University, Special Report 47, Reference 75-10, November 1975.

A non-linear one-dimensional numerical model of a canal or estuary of trapezoidal cross-section has been developed. The model solves the dynamic equation, the kinematic equations of water, salt and a passive contaminant and the equation of state relating the density field to the salinity field. It has been verified with respect to a number of simple analytic solutions of the relevant equations. Incorporated into the model, as an option, is the ability to predict the variations, during a tidal cycle, of the concentration of salt or contaminant at the "ocean" boundary, the only requirement being that an "oceanic" concentration value be defined. The report includes an annotated copy of the relevant computer program. References (12 items).

Ince, S., and Jamieson, W.W. Field and Model Studies for Visakhapatnam Harbor. Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, vol.II, 1975, Chapter 88 (p.1503-1523).

Model studies and analysis of oceanographic and littoral drift data were undertaken to advise Howe India (Private), Ltd. on littoral drift, siltation and shore erosion problems to be encountered during and after the construction of Visakhapatnam Outer Harbor Project. Distorted fixed-bed and movable bed models with a horizontal scale of 1:300 and a vertical scale of 1:80 were calibrated to reproduce the integrated net effect of an average southwest and northeast monsoon season. Experiments were conducted to assess and predict seasonal changes resulting from the construction of the system of breakwaters under normal and extreme conditions. Recommendations were made concerning breakwater and sand trap location, shore protection, dredging and disposal of dredged material.

Isfeld, E.O., Hay D., Rossouw, J. Field and Model Studies on a Siltation Problem in the Fraser River. Proceedings of the First Canadian Hydraulics Conference, held at the University of Alberta, May 10 & 11, 1973, p.44-63.

The paper describes a siltation problem which developed behind a training wall in the Fraser River at New Westminister and outlines field and model studies undertaken to examine remedial measures. The field studies included detailed measurements of suspended load and directional velocity profiles across various sections of the river in the area of the training wall. The model study consisted of two stages. In the first stage, the model bed was fixed and mainly suspended load was studied. In the second stage a movable bed was used and the bedload was studied. This report is concerned primarily with the objectives of the model study and the techniques employed during the first stage of testing. References (3 items).

Iwasaki, T. Computer Aid for Optimum Design of Tsunami Waves. Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, Copenhagen, Denmark, vol.I, 1975, Chapter 37 (p.642-659). (See annotation in Section I.)

Jamart, B.M., and Winter, D.F. A New Approach to the Computation of Tidal Motions in Estuaries. Hydrodynamics of Estuaries and Fjords; Proceeding of the 9th Liege Colloquium on Ocean Hydrodynamics, 1977, p.261-281.

The paper presents a summary of a new procedure for computing periodic tidal motion in estuaries with irregular boundaries and variable depth. The new method, described by Pearson and Winter (1977), appears to provide both computational speed and numerical accuracy in a wide variety of problems of practical interest. The starting point of the analysis is the standard set of vertically-integrated, time-dependent equations expressing conservation of horizontal momentum and mass in two dimensions. Since the motion in the estuary is assumed to be periodic, the dependent variables are Fourier decomposed. However, in order to avoid awkward Fourier decomposition of nonlinear terms and to decouple the different modes, advection and friction are evaluated by an iterative procedure. The time-dependent equations of motion are replaced by an equivalent set of modal equations, and it is shown that the boundary value problem consisting of the modal equations and appropriate boundary conditions can be rephrased in terms of a variational principle. The variational principle is used together with a finite element method to solve for the unknown flow variables. We describe here an application of the method to a segment of Hood Canal, Washington, where there is an interest in pollutant dispersal by tidal currents. References (13 items).

James, A. Pollution of the River Tyne Estuary -- The Use of Mathematical Models. WATER POLLUTION CONTROL, vol.75, No.3, p.322-340, 1976.

Dissolved oxygen studies and nutrient studies make up the work described in this article. Emphasis is placed on the mathematical interpretation of the results. 13 refs.

Johanson, P.A., Lorensen, M.W., and Waddell, W.W. A Multi-Parameter Estuary Model. Proceedings of the Conference on Environmental Modeling and Simulation, April 19-22, 1976, Cincinnati, Ohio, p.111-114. U. S. Environmental Protection Agency, EPA 600/9-76-016, July 1976.

To obtain information needed in the development of a water quality plan for Grays Harbor, in Washington State, the mathematical water quality model EXPLORE was modified for application to the harbor and the lower Chehalis River. This report describes the model selection criteria and the procedures used in applying the model to a tidally influenced estuary and river. Results of the study show that model calculations and observed data correlate well, confirming that the model is a valuable tool for evaluating the effects of various waste discharge schemes on the quality of a water body and thus for helping to select a plan for managing water resources. The study also indicates that further information about rates of benthic oxygen demand and the oxygen content of incoming seawater would improve the accuracy of the model calculations. References (8 items).

Johnson, R.W. A Simulation Model for Studying Effects of Pollution and Freshwater Inflow on Secondary Productivity in an Ecosystem. Ph.D. Thesis, Department of Marine Sciences, North Carolina State University at Raleigh, 1974.

A simulation type mathematical model of the Galveston Bay, Texas, ecosystem was developed using operations research technology. Secondary productivity measured by harvestable species (fish, crabs, shrimp) was evaluated in terms of man-related and controllable factors (quantity and quality of fresh water inflow and pollutants). Ecosystem responses to reduced pollution input and changes in freshwater inflow were evaluated and studied to determine management options. The model used information from an existing physical parameters model and relevant biological measurements. One purpose was to provide predictive information for estuarine pollution control and fisheries management (especially of migrating species such as menhaden, trout, bass, croaker, shrimp, crabs). Another purpose was to identify biological, chemical, and physical parameters needed to develop models for similar ecosystems. The model can be adapted to other ecosystems in the same temperature zone (approximately the same latitude and weather conditions). For other temperate zones and/or different environmental conditions (rain, tides), studies must determine similarities among consumers, food types and availability, and seasonal growth characteristics. Model calibration and verification need comprehensive sampling and other data (commercial catch records, weather data, etc.). Such models provide an optimized basis for analysis using all available information. References (65 items).

Kérisel, T. Aménagement de l'estuaire de la Seine. Approfondissement du chenal d'accès au port de Rouen (Development of the Seine Estuary. Increasing the Depth of the Shipping Channel to the Port of Rouen). LA HOUILLE BLANCHE, vol.29, No.1/2, p.55-66, 1974. (In French.)

A theoretical and loose-bed model study from 1967 to 1969 of the effect of submersible and nonsubmersible channel dykes

and of deepening the channel by dredging scour-resistant sills. Work was carried out from 1970 to 1972; its effects and lessons to be learned from it are discussed.

King, D.B., Jr. The Dynamics of Inlets and Bays. Coastal and Oceanographic Engineering Laboratory, Technical Report No.22, March 1974.

The equations for tidal flow through inlets into bays have been studied by many investigators. Perhaps the best known is the one by Keulegan in 1951. He considered nonlinear friction but assumed no inertia in the inlet, no river discharge constant inlet cross-section and bay surface area over a tidal cycle, and uniform bay elevation. This study analyzes these assumptions in four models; an inertia model, a river discharge model, a changing area model and a shallow water wave model, and predicts their effects. The results are presented in graphical and equation form. They are then compared with real inlets and the limitations of each model are discussed. Bibliography (28 items).

King, D.B., and Shemdin, O.H. Modeling of Inlet-Bay Systems in Relation to Sand Trapping, Symposium on Modeling Techniques, 2nd Annual Symposium of the Waterways, Harbors and Coastal Engineering Division of ASCE, San Francisco, California, September 3-5, 1975, vol.II, p.1623-1637.

Models of inlet-bay systems are considered through the use of the equations of motion and continuity. The models include inertia in the inlet, changing cross sectional area in the inlet, changing surface bay area and considers river discharge. Previous analytical models simplify such considerations and predict symmetric flows in and out of inlets over a tidal cycle. The nonlinear friction in the inlet coupled with the above considerations produce asymmetric flows over a tidal cycle of varying degrees. The sediment transport capability of inlets is considered in terms of power of the flow rates. The inlet-bay systems are interpreted in light of their capability to trap sand from the littoral zone. It is found that some inlets behave as sinks and others eject sand to the ocean. This depends on the repletion coefficient as defined by Keulegan and on whether the inlet cross sectional area or bay surface area increase with the tidal elevation as in marsh regions. The sand trapping capability is also investigated in light of the phase shift between the ocean tide and the inlet current. The model results are discussed in light of observations obtained from Florida inlets. References (4 items).

Kjelson, M. A., and Colby, D.R. The Evaluation and Use of Gear Efficiencies in the Estimation of Estuarine Fish Abundance. Estuarine Processes; Volume II, Circulation, Sediments, and Transfer of Material in the Estuary, edited by Martin Wiley. New York, Academic Press, 1977, p.416-424. (See annotation in Section I.)

Klemas, V., Otley, M., Wethe, C., et al. Monitoring Coastal Water Properties and Current Circulation with Spacecraft. Second Joint Conference on Sensing of Environmental Pollutants, Washington, D.C., December 10-12, 1973, p.343-354. (See annotation in Section VII.)

Krone, R.B., and Ariathurai, R. Application of Predictive Sediment Transport Models. In: Dredging: Environmental Effects & Technology; Proceedings of WODCON VII, San Francisco, California, July 10-12, 1976, p.259-272.

This paper presents a brief description of a new mathematical model of cohesive sediment transport and describes several of its potential applications. References (3 items).

Kuhn, G.D., and Nielsen, J.N. Application of Boundary-Layer Theory to Dispersion in Well-Mixed Estuaries. Nielson Engineering & Research, Inc., NEAR TR 63, September 1974. (See annotation in Section I.)

Kuo, A.Y. A Model of Tidal Flushing for Small Coastal Basins. Proceedings of the Conference on Environmental Modeling and Simulation, April 19-22, 1976, p.543-547. U. S. Environmental Protection Agency, EPA 600/9-76-016, July 1976.

An empirical theory is proposed to model the flushing of a small coastal basin by tidal exchange. The theory is adapted from Ketchum's tidal prism concept with modification. The application of the method requires that a water body be divided into segments such that complete mixing at high tide within each segment may be assumed. Starting from the mouth, each segment is defined such that its volume at low tide equals the total tidal prism landward from the inner boundary of the segment. Therefore, each segment has a length equal to the local tidal excursion. The flushing capability of a

segment is defined as the fraction of dissolved substance removed per tidal cycle, i.e. the flushing rate, which was derived from the principle of mass-balance. The concentration distribution of an introduced pollutant was expressed in terms of discharge rate, volume, flushing rate, and decay rate. A model has been set up for the Cockrell Creek of Virginia to study a proposed 0.2 MGD STP. The model was used to project the distribution of fecal coliform bacteria and biochemical oxygen demand. References (4 items).

Kuo, A.Y., Nichols, M., and Lewis, J. Modeling Sediment Movement in the Turbidity Maximum of an Estuary. Virginia Polytechnic Institute and State University, Blacksburg, Virginia, Water Resources Research Center Bulletin No.111, June 1978.

A two dimensional, time dependent numerical model to simulate the movement of water and suspended sediment in the turbidity maximum of an estuary was developed. The model is a systematic sequence of mathematical procedures derived from the mass-balance equation and the equation of motion. Lateral integration was used to obtain two dimensional equations. These equations were integrated with depth over the height of successive layers. Finite difference equations then were written for each layer and solved numerically using prescribed boundary conditions. The model yields values for time varying tidal height, current speed, salinity, and suspended sediment concentration (turbidity) throughout the estuary. References (32 items).

Kuo, C.Y. Effects of Salinity on Turbulent Diffusion of Pollutants. Water Resources Research Institute, Research Center, University of Puerto Rico, Mayaguez, UPRICO-WRRI-PR-73-74, December 1973. (See annotation in Section IV.)

Kuur, P. van der, and Verboom, G.K. Computational Analysis for Optimal Boundary Control of Two-Dimensional Tidal Model. Proceedings, XVIth Congress of the International Association for Hydraulic Research, São Paulo, Brazil, July 27 to August 1, 1975, vol.1, Paper A38.

For the tidal salinity model Europoort a new sea-boundary control system had to be designed. To find out which control system was the most suitable, different mathematical models (1- and 2-dimensional analytical, 2-dimensional numerical) were used. Results of the investigations with these models will be shown. References (5 items).

Laevastu, T., Callaway, R., Stroud, A., et al. *Computation* of Tides, Currents, and Dispersal of Pollutants in the New York Bight from Block Island to Atlantic City with Large Grid Size, Single and Two-Layer Hydrodynamical-Numerical Models. Part 4. Environmental Prediction Research Facility (Navy), Monterey, California, Technical Note No.4-74, January 1974.

The application of a large grid hydrodynamical-numerical model to the New York Bight is to a large extent a problem of heating two long open boundaries. The input at these open boundaries also serves for tuning of the results inside the computational area. A few earlier current measurements by two lightships in the Bight have been used for verification. The tidal currents predominate in the New York Bight proper, with a superimposed slow net flow toward the south. This net flow can be simulated in the models and tuned with the prescription of a proper slope to the two open boundaries. References (9 items).

Laevastu, T., Clancy, M., and Stroud, A. *Computation* of Tides, Currents and Dispersal of Pollutants in Lower Bay and Approaches to New York with Fine Medium Grid Size Hydrodynamical-Numerical Models. Part 3. Environmental Prediction Research Facility (Navy), Monterey, California, Technical Note No.3-74, January 1974.

Results of two different hydrodynamical-numerical model applications with different grid sizes--one with a small grid size for the Lower Bay of New York, and the other with a larger grid size for the approaches to New York, including part of the New York Bight outside the Ambrose Channel--are summarized. References (4 items).

Lai, C., and Onions, C.A. Computation of Unsteady Flows in Rivers and Estuaries by the Method of Characteristics. U. S. Geological Survey, Report No. USGS/WRD/CC-76/034, June 1976.

Report is a program documentation to the latest revision (1975) of the unsteady open-channel flow simulation model by the *method of characteristics*, Version 13 in the program series, which employs a multiple-reach scheme treating each subreach as a prismatic shape. A long waterway of variable cross section,

properties and coefficients may be divided into a number of subreaches, each being considered uniform in geometry and in other factors. The basic method of characteristics using specified time intervals is applied to each subreach, and additional boundary conditions are imposed at the junctions between subreaches. For the user's convenience, the program incorporates several types of options covering input, accuracy, boundary conditions, data formats, output, and continuation. The program accepts input data in three forms -- data cards only, cards and user-supplied subroutines, and cards and disk stage data. Boundary values are either stage or velocity and are given either in numerical data or equation form. The user may employ or bypass the extrapolation procedures by weighing the trade-off between accuracy and computer time. By eight output options provided in the program he can also tailor the outputs to suit his need and convenience. References (5 items).

Lambert, W.P., and Fruh, E.G. Methodology to Evaluate Alternative Coastal Zone Management Policies: Application in the Texas Coastal Zone. Special Report III: A Methodolgy for Investigating Fresh Water Inflow Requirements of a Texas Estuary; Volume I--Methodology. University of Texas at Austin, Center for Research in Water Resources, Environmental Health Engineering Research Laboratory, Technical Report EHE-76-01, CRWR-133, no date. (See annotation in Section I.)

Largest Estuarine Model Dedicated. WORLD DREDGING & MARINE CONSTRUCTION, vol.12, No.7, p.16-17, June 1976.

Brief description of the largest estuarine model in the world, the Chesapeake Bay Hydraulic Model. Model was built to scale of 1:1000 horizontally and 1:100 vertically, for the U. S. Army Corps of Engineers.

Lean, G.H., and Weare, T.J. Modeling Two-Dimensional Circulating Flow. Journal of the Hydraulics Division, Proceedings, ASCE, vol.105, No.HY1, p.17-26, January 1979.

Theoretical analysis and numerical experiments are presented to demonstrate some of the difficulties in modeling two-dimensional circulating flow. It is shown that in cases of practical interest the lateral mixing of momentum, which is essential to support the circulation, can arise in computational models from wholly spurious numerical dispersion effects. Laboratory flume measurements of the flow in the wake of a plane obstruction are presented. It is shown that the horizontal velocity profiles across the eddy indicate that the turbulent lateral mixing rate is appropriate to a shear layer mixing rather than to bed-generated turbulence. Criteria for the conditions under which shear layer turbulence dominates are presented. The practical implications for numerical and physical models are reviewed. References (10 items).

Lee, Y.S. A Mathematical Model of Unsteady, Two-Layer Flow in a Highly Stratified, Variable-Area, Tidal Estuary. Ph.D. Dissertation, Mississippi State University, Department of Civil Engineering, August 1975.

For a highly stratified estuary, an interfacial region of large salinity gradients is defined and two-layer flow system always exists. The proposed mathematical models involve a two-layer hyrdodynamic model and a two-layer mass conservation model for a stratified, variable-area, intratidal estuary. The hydrodynamic model is used to determine the horizontal advective transport, either as longitudinal discharge and layer depth or as longitudinal velocity throughout the two-layer estuary. With the calculated discharge and layer depth from the hydrodynamic model as input, the mass conservation model is then used to describe instantaneous, time average or slacktide salinity distributions in a two-layer stratified estuary. A two-layer hydrodynamic model, including the continuity and momentum equations for each layer, has been formulated under three assumptions: 1) one-dimensional flow for each layer; 2) hydrostatic pressure; 3) incompressible fluid and constant density for each layer. An equation to define the interface or salt wedge and the upstream boundary for the two-layer model was derived from the hydrodynamic model under steady state conditions. A two-layer mass conservation model consisting of two mass transfer equations, one for the upper and one for the lower layer, were also formulated under the following assumptions: 1) for each layer a uniform concentration of substance over the cross-sectional area, thus the only concentration gradient, is along the longitudinal axis in the direction of flow; and 2) vertical mass transfer across the interface into each layer takes place by entrainment. The solution of the salt wedge equation was obtained by a Runge-Kutta Method. In a hypothetical study-case, variable quantities such as fresh water flow and relative density-differences were studied. It showed that the salt front or interface is forced downstream by increasing fresh water flow

but is forced upstream by increasing relative density-difference. The simultaneous solutions of the two-layer hydrodynamic model and the two-layer mass conservation models for a stratified, variable-area, intratidal estuary were achieved by means of a four-point and a six-point implicit finite difference schemes, respectively. The resulting mathematical models provided a convergent and stable solution, even when steep gradients due to cross-sectional area changes in the estuary existed. For the hypothetical study-case, the variation of interfacial friction coefficient, f_i, between 0.0008 and 0.0032, has a significant effect on the interface location and the velocities in the upper and lower layers but has little effect on the surface elevation. The side wall friction effects on the solution are negligibly small. Salinity profiles in the upper layer increase upstream with increasing longitudinal dispersion and entrainment coefficients. However, in the lower layer the profiles increase upstream with increasing longitudinal dispersion coefficient but with decreasing entrainment coefficient. The sensitivity analysis on the longitudinal dispersion coefficients, D_1 and D_2 in the upper and lower layers indicated that differences between the salinity profiles in each layer depend upon the value of entrainment coefficient f'. Solutions of the proposed mathematical models were compared with field data taken in the Escatawpa Estuary in Mississippi. One set of field data measured or collected by the Jackson Office, U. S. Geological Survey, Water Resources Division, in July-September 1972 was used for this part of the study. Bibliography (42 items).

Leendertse, J.J., and Liu, S.-K. Comparison of Observed Estuarine Tide Data with Hydraulic Model Data by Use of Cross-Spectral Density Functions. The New York City Rand Institute, R-1612-NYC, September 1974. (See annotation in Section VIII.)

This report presents an analysis of observed tide level data in Jamaica Bay by use of cross-spectral density functions and similar analyses of tide data measured in a physical model of that bay at the Waterways Experiment Station of the U.S. Army Cops of Engineers in Vicksburg, Mississippi. The results of the latter study were used to adjust the model in order to make possible accurate simulations of present and projected tide conditions in Jamaica Bay. The effects on tide levels, currents, water quality, and navigation conditions of a proposed hurricane barrier accross the entrance of Jamaica Bay are presently being studied. Because the physical model is used to predict current patterns and tide levels resulting from different barrier designs, it had to be precisely adjusted for the present condition in order to make accurate predictions. The analysis started with model conditions obtained by the conventional method of model adjustment, i.e., that in which the model engineer tries to match a so-called average tide obtained from several tidal cycles in the field with the periodic tide in the model by changing the flow resistance in the model. In this investigation cross-spectral analysis was used to establish the amplitude and phase relationships for different tidal components between pairs of tide level stations in the bay and in the model. This made it possible to compare very accurately the propagation and amplification of these tidal components in the model with those in the bay, even though actual tide level variations at the bay entrance could not be reproduced by the model. By means of this information the flow resistance in the model was further adjusted in two steps by adding resistance strips in the channels until the amplitude and phase relationships obtained from the model were in agreement with those obtained from prototype data for the tidal components. The study resulted in the following conclusions: (i) The tidal amplification and phase lag between two observation series in the prototype or in a hydraulic model can be determined accurately by cross-spectral analysis. (ii) This technique can be used effectively for adjusting hydraulic models driven by periodic tides only, and is particularly effective for adjusting models with many branches. (iii) The phase lags and amplification of the semidiurnal tide in the Jamaica Bay model, after adjustments by use of the cross-spectral method, agree well with those obtained from field measurements. References (5 items).

Leendertse, J.J., and Liu, S.-K. Modeling of Three-Dimensional Flows in Estuaries. Symposium on Modeling Techniques, 2nd Annual Symposium of the Waterways, Harbors and Coastal Engineering Division of ASCE, San Francisco, California, September 3-5,1975, vol.I, p.625-642.

The paper describes the computational principles of simulating three-dimensional flows in estuaries, bays and coastal seas in which nonisotropic density conditions may exist. Numerical integration of the finite difference equations for motion, continuity and for the transport of salt and heat are used. With this model, the computed salinity and temperature distributions are coupled

to the flow computation by a nonlinear equation of state. An approximation for the sub-gridscale effect is introduced by use of mass heat and momentum exchange coefficients. The vertical exchanges for stable or unstable vertical stratification are estimated according to the local Richardson number. References (11 items).

Leendertse, J.J., and Liu, S.-K. A Three-Dimensional Model for Estuaries and Coastal Seas: Volume II, Aspects of Computation. The Rand Corporation, R-1764-OWRT, June 1975.

This report describes different computational aspects of the use of a three-dimensional finite-difference model of estuaries, bays, and coastal seas. With this model, salinity and temperature distributions can be computed, together with the flow field, then coupled to the flow computations by a complicated equation of state. In the model an approximation for the sub-gridscale effects is introduced by use of mass and momentum exchange coefficients. The vertical exchanges are dependent on the Richardson number. The computational method is tested on bays and estuaries with widely different characteristics. The results of these experiments are presented in graphic form. It is concluded that effective simulations can be made with the model. References (33 items).

Leendertse, J.J., and Liu, S.-K. A Three-Dimensional Model for Estuaries and Coastal Seas: Volume IV, Turbulent Energy Computation. The Rand Corporation, R-2187-OWRT, May 1977.

Three-dimensional flows in water bodies with nonhomogeneous density can be computed by use of a finite difference model which contains an equation of continuity, equations describing conservation of momentum, salinity, temperature, subgrid-scale energy, and an equation of state. In the model, vertical accelerations are neglected, but not the vertical velocities. The vertical exchange coefficients are computed from the subgridscale energy intensity. Experiments made with the model produced velocity distributions which typically occur in coastal areas. References (16 items).

Leendertse, J.J., and Liu, S.-K. A Three-Dimensional Turbulent Energy Model for Nonhomogeneous Estuaries and Coastal Sea Systems. Hydrodynamics of Estuaries and Fjords; Proceedings of the 9th Liege Colloquium on Ocean Hydrodynamics, 1977, p.387-405. (See annotation in Section I.)

Leendertse, J.J., and Liu, S.-K. A Water-Quality Simulation Model for Well Mixed Estuaries and Coastal Seas: Volume VI, Simulation Observation, and State Estimation. The New York City Rand Institute, R-1586-NYC, September 1974.

The report describes the water-quality simulation of post-rainstorm coliform bacteria distributions in Jamaica Bay, New York, by use of models of the drainage basins surrounding the bay and a water-quality simulation of the bay itself. A stochastic analysis method was introduced into the investigation to assess the behavior and resolving power of the water-quality simulation model and to derive an optimal estimate of missing input data. The estimates obtained by simulation agree well with those obtained by field measurements, except near Bergen Basin, where an unknown source of coliform bacteria exists. The origin and extent of this input should be determined from new field surveys. Since the response to a rainstorm of all major components of this urban estuarine system can be determined, the models described in this report will provide the basis for the optimal design and management of an auxiliary treatment system for sewer overflows of the drainage basins around the bay. References (9 items).

Leendertse, J.J., and Liu, S.-K. A Water-Quality Simulation Model for Well Mixed Estuaries and Coastal Seas: Volume VIII, An Engineering Assessment. The New York City Rand Institute, R-1791-NYC, December 1975. (See annotation in Section IV.)

Leendertse, J.J., Alexander, R. C., and Liu, S.-K. A Three-Dimensional Model for Estuaries and Coastal Seas: Volume I, Principles of Computation. The Rand Corporation, R-1417-OWRR, December 1973.

The report describes the principles of computation for a three-dimensional model of estuaries, bays, and coastal seas in which non-isotropic density conditions exist. Numerical integration of the finite difference equations for motion, transport, and continuity are used. In these equations the vertical momentum exchange is quadratically related to horizontal velocities, and the effects of vertical accelerations are neglected. The computational method has been tested on a number of basins with boundaries of increasing complexity. A computation for a large lake with irregular boundaries and depth with a horizontal grid of 1000 points and 8 layers took 30 minutes on an IBM 360-91 for a real-time simulation of 67 hours in 4000 time steps. Results indicate that three-dimensional

flows can be computed effectively according to the method described in this report. References (14 items).

Leendertse, J.J., Liu, S.-K., and Nelson, A.B. A Three-Dimensional Model for Estuaries and Coastal Seas: Volume III, The Interim Program. The Rand Corporation, R-1884-OWRT, October 1975.

A computer program of a three-dimensional model for estuaries and coastal seas is presented. The program can perform numerical integration of the equations of motion, the equation of continuity, and the equations representing transport of salt and temperature. A complicated equation of state is used. Vertical mass and momentum transfer coefficients are computed from density and velocity information.

Lehmann, E.J., Editor. Thermal Pollution. Part 3. Hydrology and Hydrodynamics (A Bibliography with Abstracts). Search Period Covered 1964 - March 1976. National Technical Information Service, Springfield, Va., March 1976. NTIS/PS-76/0130 (Supersedes NTIS/PS-75/220). (See annotation in Section IV.)

Lepetit, J.-P. Stabilité du chenal d'accès au nouvel avant-Port de Dunkerque (Stability of the Access Channel of the New Outer-Harbour of Dunkerque). Proceedings, XVIth Congress of the International Association for Hydraulic Research, São Paulo, Brazil, July 27 to August 1, 1975, vol.1, Paper A28. (In French.)

The new outer-harbor of Dunkerque has been studied on a movable-bed model (scales 1/400e - 1/60e) calibrated by reproducing radioactive tracer experiments and historical bottom evolutions. The navigation channel dredged in shallow water perpendicular to alternative tidal currents tends to move in the direction of the predominant bed load transport and the deposit rate seems equal to the difference but not to the sum of the two opposite bed load transports. The first field data collected during harbor construction confirm these results. Reference (1 item).

Lepetit, J.-P., Cazenave, M., and Davesne, M. Complementairité des modèles physique et mathématique pour l'étude de l'échauffement d'un estuaire sur un site de centrale électrique. Proceedings, XVIth Congress of the International Association for Hydraulic Research, São Paulo, Brazil, July 27 to August 1, 1975, vol.3, Paper C22. (In French.)

This study of the discharge of electric power plant cooling water in estuary is conducted first on a one-dimensional mathematical model solving Saint-Venant equations and heat dispersion and exchange relations, then on a scale-model. The first one, including heat exchange with the atmosphere, gives the far-field heating useful to predict influence on ecology; the second one gives a more detailed picture of the near-field and the importance of recirculation. Such a method has been applied to the power station of "Le Blayais" on Gironde estuary. The results obtained on both models were complementary and very similar in the farfield. Tests on scale-model have led to the optimal disposal of inlet and outlet and values of temperature obtained on scale-model after running 15 tides, without atmospheric exchange, are very close to those calculated with atmospheric exchange. So the mathematical model confirms results of scale-model.

Lespine, E. Aménagement de l'estuaire de la Gironde (Development of the Gironde Estuary). LA HOUILLE BLANCHE, vol.29, No.1/2, p.71-78, 1974. (In French.)

Description of a comprehensive study program which has been in progress for nearly ten years. The following are the most important items covered:- (i) Analysis of hydraulic conditions, sediment behavior and other natural effects. (ii) Identification of bed materials (bedrock location and depth of overlying alluvium). (iii) Determination of works required to improve the main shipping channel without additional maintenance dredging (fixed and loose-bed model tests). A sustained effort was made throughout the investigations to analyze the 'reactions' of the estuary to structures erected in the past and to predict the effects of future works (deepening, dikes, dams, massive backfilling to provide new industrial areas, etc.) on the mechanism of sediment behavior. As a result, the following were determined: (i) Optimum conditions for deepening the shipping channels to Le Verdon for 250,000 tdw tankers with a 20 m draught. (ii) Characteristics of the main estuary works, which will assist self-cleaning of the shipping channel and allow the depth of the channel to be substantially increased right into the heart of Bordeaux. (iii) Works in the Le Verdon area provided for in the Sixth Plan, which also forms part of the general scheme for the combined industrial area and port under investigation in the

studies, are now in progress. With discussion.

Liu, P.L-F., and Lennon, G.P. Finite Element Modeling of Nearshore Currents. Journal of the Waterway, Port, Coastal and Ocean Division, Proceedings, ASCE, vol.104, No.WW2, p.175-189, May 1978.

A finite element model is developed to compute the nearshore currents induced by breaking waves in the surf zone. The normal incident wave system is employed so as to study the effects of beach topography on the current circulation patterns. The beach topography considered here is of linear plane beach shape with minor undulations in the longshore direction. Ignoring the lateral turbulent diffusion, the finite element representation of the governing equations of mean currents is obtained by the method of weighted residuals. It is shown that, due to the flexible grid discretization, this model can be used to study problems containing more complex beach topography within a large area of interest. Two types of alongshore beach undulations are investigated: rhythmic topography and localized irregular topography. The locations of rip currents depend on the surf zone width and the on-offhsore variation of beach profile. References (12 items).

Liu, S.-K., and Nelson, A.B. A Three-Dimensional Model for Estuaries and Coastal Seas: Volume V, Turbulent Energy Program. The Rand Corporation, R-2188-OWRT, May 1977.

A computer program of a three-dimensional model, including subgridscale turbulent energy for nonhomogeneous estuaries and coastal seas is presented. The computer code is programmed for the implementation of computation methods described by Leendertse and Liu (A Three-Dimensional Model for Estuaries and Coastal Seas: Volume IV, Turbulent Energy Computation, The Rand Corporation, R-2187-OWRT, May 1977). The program can perform numerical integration of the equations of motion, continuity, transport of salt, heat, turbulent energy, and a pollutant constituent. The dynamic fields of salinity and temperature are coupled to the equations of motion through the use of a nonlinear equation of state. The effect of the vertical density gradient on the vertical exchange is evaluated by the Richardson number computed using the local turbulent energy level. In addition to the main computer program, the variable definitions, input parameters, implementation, and operational aspects are described, followed by a sample case. References (4 items).

Long, R.R. Lectures on Estuarine Circulations and Mass Distributions. The Johns Hopkins University, Departments of Earth & Planetary Sciences and Mechanics & Materials Science, Technical Report No.9 (Series C), December 1976. (See annotation in Section I.)

Long, R.R. Three-Layer Circulations in Estuaries and Harbors. The Johns Hopkins University, Departments of Mechanics & Materials Science and Earth & Planetary Sciences, Technical Report No.8 (Series C), September 1976. (See annotation in Section I.)

Long, R.R. Three-Layer Circulations in Estuaries and Harbors. JOURNAL OF PHYSICAL OCEANOGRAPHY, vol.7, No.3, p.415-421, May 1977. (See annotation in Section I.)

Longhurst, A.R. Ecological Models in Estuarine Management. OCEAN MANAGEMENT, vol.4, No.2-4, p.287-302, December 1978.

Current practice in the use of ecological models in water quality management of estuaries is almost exclusively restricted to very simple models of dissolved oxygen and biochemical oxygen demand; these models ignore almost the entire range of ecological interactions which actually occur in large estuaries and which transform organic matter and modify oxygen levels, yet nevertheless they are capable of realistic simulation and prediction. It is suggested that this is often because the modelled ecosystems are simplified due to pollution and/or very short water residence-time in the estuaries being modelled. More comprehensive ecological simulation models of estuaries are not being tested, and the nature of their output, and their application to practical estuarine water quality management are reviewed. It is suggested that the most comprehensive models have as their main role the understanding of the nature of simulations performed by simple models, and most importantly, in the prediction of the effects of major climatic or technological changes to estuaries. For instance, the effects of tidal power generation schemes, as proposed for Severn and Fundy, can only be predicted by large comprehensive models such as the NERC GEMBASE. Without the use of such models, prediction must be nonquantitative even if it is objective. References (21 items).

Lucas, A.H., and Cathers, B. Navigable Harbour Entrances Analysed by Hydraulic Models. Proceedings, XVIth Congress of

the International Association for Hydraulic Research, São Paulo, Brazil, July 27 to August 1, 1975, vol.1, Paper A17.

This paper describes a possible technique for maintaining a navigable harbor entrance. The method involves the use of a fluid pressure to assist in the controlled erosion of channels through ring bars which tend to form outside harbor entrances. The concept is to locate pipes buried at an appropriate depth across where the ring bar usually forms. The effect of the air or water flow emanating from suitably spaced holes in the pipe is to fluidize the sand or at least to increase the pore water pressure and flow in the overlying sand. This reduces the critical stress and hence the velocity of water necessary in the channel to mobilize the sand particles. A comparison of the effects of using both water and air as the fluidizing agent is made. A series of model tests in a flume were conducted until an empirical minimum energy cross section was attained that was in equilibrium under the influence of the tidal currents and water flow from the pipe. Rules for scaling are deduced and the feasibility of the system is then examined from both the viewpoints of the energy requirements and the channel dimensions achieved. References (5 items).

Lutz, G.A., Hubbell, D.W., and Stevens, H.H., Jr. Discharge and Flow Distribution, Columbia River Estuary. U.S. Geological Survey, Professional Paper 433-P, 1975. (See annotation in Section VIII.)

Lynch, D.R., and Gray, W.G. Analytic Solutions for Computer Flow Model Testing. Journal of the Hydraulics Division, Proceedings, ASCE, vol.104, No.HY10, p.1409-1428, October 1978.

A class of solutions to the linearized shallow water equations is presented. The solutions involve two spatial dimensions plus time, and special emphasis is placed on the dynamic steady state. The results are intended for use in testing and verification of numerical models. The class of problems treated allows an independent assessment of the effects of wind stress, variable bathymetry, frictional dissipation, and nonrectangular boundaries on model performance. References (15 items).

Maddock,L., and Pingree, R.D. Numerical Simulation of the Portland Tidal Eddies. ESTUARINE AND COASTAL MARINE SCIENCE, vol.6, No.4, p.353-363, April 1978.

A numerical model in the Portland region simulates the hourly development of the Portland eddies. These eddies are generated by vorticity derived as the tide curves around Portland Bill. The hour by hour development of tidal streams is then summarized in terms of the tidal ellipse properties for this region. References (8 items).

Martin, J.M., Meybeck, M., Salvadori, F., et al. Pollution chimique des estuaires: etat actuel des connaissances; revue bibliographique arrêtée en juin 1974 (Chemical Pollution of Estuaries: Present State of Knowledge; Bibliographic Review Ending June 1974). Publications du Centre National pour l'Exploitation des Oceans (CNEXO) Serie: Rapports scientifiques et techniques No.22, 1976. (In French.) (See annotation in Section IV.)

Masch, F.D., and Brandes, R.J. Simulation of Tidal Hydraulics - Masonboro Inlet. Symposium on Modeling Techniques, 2nd Annual Symposium of the Waterways, Harbors and Coastal Engineering Division, ASCE, San Francisco, California, September 3-5, 1975, vol.1, p.220-239.

A two-dimensional finite difference tidal hydrodynamics model has been adapted to Masonboro Inlet, NC. The model was calibrated for prototype conditions of September and October 1969. Operational runs simulated tides and currents corresponding to preproject undeveloped inlet conditions of November 1964, and modified inlet and north jetty conditions of June 1967. For each case, the model was operated with mean and spring tides. The model applied uses an explicit numerical solution of the two-dimensional equations of motion and continuity. It accounts for the effects of variable bathymetry, bottom roughness, tidal inundation, wind setup, weir flow over a section of the jetty and other system features. Because of the size and detail required in the simulations, a dual-model approach was employed. In this procedure, a coarse grid model was used to compute tidal flows which were then applied as boundary conditions to a fine grid submodel of the immediate inlet area. Verification of the dual-grid model was accomplished through comparisons of measured and simulated tides at six gage locations and measured and simulated tidally generated velocities at fifteen stations throughout the inlet area. Further verification was obtained through comparisons of tidal prisms in

selected areas common to the coarse and fine grid models. Results of operating the models under different ocean tides and with pre- and post-project bathymetry included water surface elevation and tidal velocity simulations at each of the stations used in the model verification. Literature Cited (11 items).

Mattis, W.E., and Klafter, R.D. Optimal Waste Discharge in Estuaries and Bays. International Federation of Automation Control, World Congress, 5th, held in Paris, France, June 12-17, 1972, Proceedings, Part 3, Paper 9.2. (See annotation in Section IV.)

Mavrigian, G., Sarikelle, S., and Carpenter, J.W. Circulation Patterns Behind a Porous Breakwater. Sixth Annual Offshore Technology Conference, May 6-8, 1974, Houston, Texas, Preprints, vol.II, Paper No. OTC 2123, p.943-950.

Experimental studies have been conducted on a porous breakwater model composed of a tube network, to determine its effectiveness in flushing out contaminants from harbors. Non-porous types of breakwaters interfere with circulatory patterns of natural currents and curtail exchanges of water between the open sea and the harbor. The porous breakwater reveals definite advantages: flows through the breakwater supply a continuous circulation of fresh water within a given harbor area, reducing the build-up of stagnant or contaminated waters. Color photographs were made of dye injected into the tube network to delineate the flow patterns in the harbor. Circulation patterns resulting from wave-induced flow were determined for three breakwaters under varying wave characteristics. References (12 items).

Mayor-Mora, R. Hydraulics of Tidal Inlets on Sandy Coasts. Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, Copenhagen, Denmark, vol.II, 1975, Chapter 89 (p.1524-1545).

A series of laboratory experiments was carried out on an idealized ocean-inlet-bay system subjected to reversing flows caused by tidal and surface wave actions. The testing was done in a rectangular basin simulating a "bay" or "lagoon" and separated from an "ocean" basin by a sand barrier across which inlet pilot channels of varying cross sections and lengths were cut prior to starting each run; the ocean side of the barrier formed a 1:30 flat beach throughout the tests. Disturbances in the ocean were created by tide and wave generators. Their effects in the bay and inlet channel were measured by water level and current velocity recording units. Experimental measurements are presented here in normalized form in order to determine the relationships governing the hydraulic behavior of a tidal inlet. These results are also compared to those obtained from a numerical approximation (the lumped parameter approach), all as functions of a proposed coefficient that includes the ocean-inlet-bay system characteristics. The experimental findings are further compared to available field data. Investigation of the effects of surface waves, controlling jetties, and fresh water inflow into the bay on the dimensionless parameters are also explored. References (3 items).

McChesney, S.W., and Edge, B.L. A Mathematical Model for Water Quality Evaluation in the South Carolina Grand Strand. Water Resources Research Institute, Clemson University, South Carolina, Report No.45, September 1976.

WRRI Project No. S-034-SC, April 1, 1971-December 31, 1972. The purpose of this study was to develop a suitable mathematical model for simulating water quality in the Intracoastal Waterway behind Myrtle Beach, South Carolina. Within this context, the Custer-Krutchkoff estuary model and the FWQA dynamic estuary model were used to provide a stochastic aspect to the available deterministic, dynamic models. The stochastic addition to these models gives the user a more complete knowledge of the effects of discharges of pollutants on the water quality of an estuary. Instead of a single specific value for a water quality parameter, as would be obtained from a deterministic model, the stochastic model is able to predict a range of values along with their frequency of occurrence. References (25 items).

McCoy, J.E., and Edge, B.L. Methodology for Applying the Finite Element Method to Partially Stratified Estuaries. Water Resources Research Institute, Clemson, University, South Carolina, Report No.66, January 1977. (See annotation in Section I.)

McDowell, D.M., and O'Connor, B.A. Hydraulic Behaviour of Estuaries. New York, John Wiley, 1977. (See annotation in Section I.)

McHugh, G.F. Development of a Two-Dimensional Hydrodynamic Numerical Model

for a Shallow well-Mixed Estuary. Louisiana State University, Center for Wetland Resources, Sea Grant Publication No. LSU-T-76-008, 1976.

Part 1 details the developmental steps that led to the creation of a two-dimensional hydrodynamic model capable of predicting water levels and current velocities within an area of arbitrary size, shape, and boundary nature (opened or closed); and capable of predicting also the location of closed boundary segments as a function of time. Restrictions on the applicability of the model are: 1) There must be negligible variations of horizontal velocity over most of the depth of the fluid layer, 2) There must be negligible vertical velocity, 3) There must be negligible vertical shear owing to horizontal velocity gredients, and 4) There must be negligible pressure and buoyancy forces arising from any small variations in salinity. In Part 2, the feasibility of computing the tidal flow through a small area of marsh (roughly 1,000 × 600 sq. ft.) using equations and solution techniques described in Part 1, is demonstrated. The model allows for the inundation of and withdrawal of water from arbitrary areas of the marsh, and is quite general in regard to the size, shape, and open or closed nature of the boundaries. References (6 items).

McKay, J.H. The Hydraulic Model of Chesapeake Bay. Estuarine Processes; Volume II, Circulation, Sediments, and Transfer of Material in the Estuary, edited by Martin Wiley. New York, Academic Press, 1977, p.404-415.

The Hydraulic Model of Chesapeake Bay is located at Matapeake, Maryland. It is a fixed bed geometrically distorted model constructed to a horizontal scale of 1 to 1000 and a vertical scale of 1 to 100, a distortion ratio of 10. The model will be operated using salt water introduced into the model ocean and fresh water flowing into the system through model tributaries. Linear goemetric scales in conjunction with model laws determine hydraulic similitude between the model and its prototype. One year of hydrologic record in nature can be reproduced on the model in 3.65 days. The model will be used in the study of many different estuarine problems, including: 1. The effects on salt water intrusion that are due to modifications of the physical or hydraulic regimen of the estuary. 2. Diffusion, dispersion, and flushing of wastes. 3. The effects of power plant cooling water discharges. 4. Tidal flooding by storm surges. The Hydraulic Model of Chesapeake Bay will be a powerful addition to the tools available for analysis of estuarine physical problems by scientists, engineers, and planners working on Chesapeake Bay.

McNair, E.C., Jr. Model Materials Evaluation; Sand Tests; Hydraulic Laboratory Investigation. U.S. Army Corps of Engineers, General Investigation of Tidal Inlets, GITI Report 7, June 1976.

A program of research conducted jointly by U.S. Army Coastal Engineering Research Center, Fort Belvoir, Virginia, and U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. A laboratory investigation was performed to define responses of a natural quartz sand to various hydraulic conditions. The results demonstrate the performance of the material in a movable-bed model and, when compared with the responses of other materials, may provide a basis for the selection of optimum materials for various movable-bed modeling requirements. Twenty-one tests were performed with a 40-ft-long beach containing an inlet and with unidirectional, steady flows through the inlet substituting for tidal flows. The geometric characteristics of the inlet channel, beach profiles, inlet configurations, and material transport were observed for conditions with and without waves and for various magnitudes of flood and ebb flows. The tests showed that the minimum channel area, the channel width at the location of the minimum area, and the hydraulic radius at the location of the minimum area were strongly related to the rate of flow through the channel. The rate of material transport was found to be weakly related to channel flow rate, but the sparseness of data observations with time precluded definite evaluation of this. The ability to scale channel geometry was demonstrated. The rate of material transport appears to be a scaleable quantity, but the scaling relations require additional experimentation for definition. References (13 items).

Mehta, A.J., and Christensen, B.A. Incipient Sediment Motion in Entrances with Shell Beds. In: Rivers '76; Symposium on Inland Waterways for Navigation, Flood Control and Water Diversions; 3rd Annual Symposium of the Waterways, Harbors and Coastal Engineering Division of ASCE, Colorado State University, Fort Collins, August 10-12, 1976, vol.II, p.960-977.

River and estuarine entrances are important components in reference to their contribution to the sand budget of the coastal zone. Whereas some entrances act as sinks for the sediment in the littoral

zone, taking in sand and depositing it in the bay, others behave as sources of sediment for the outer coastal zone. It is therefore necessary to be aware of the relationship describing the sediment transport processes in the entrances, in order to understand the precise role of the entrances in determining the overall sand budget. To test a stochastic model which predicts the critical bed shear stress for the incipient motion of coarse sediment grains at the point of bed erosion, given the grain size and bed characteristics, data were obtained at two entrances - John's Pass and Blind Pass, on the Gulf Coast of Florida. The channel beds at these passes are laden with shells, and the transport of fine sand occurs over the shell bed. Results from the analysed data failed to agree with the well-known entrainment function relationship of Shields for horizontal beds with uniform grains, but compared very well with the entrainment function derived from the stochastic model. It is noted that the discepancy with Shields' relationship is due to the non-uniformity of the shell bed and the relatively large ratio of the equivalent sand roughness of the shell bed to the median sand grain diameter. References (9 items).

Mehta, A.J., and Partheniades, E. On the Depositional Properties of Estuarine Sediments. Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, Copenhagen, Denmark, vol.II, 1975, Chapter 72 (p.1232-1251). (See annotation in Section II.)

Miles, G.V. Anisotropic Friction for Tidal Models. HRS NOTES (Hydraulics Research Station, Wallingford) No.17, p.3-4, June 1975.

Brief discussion of the advantages and disadvantages of the numerical model over the traditional physical model in the case of tidal problems.

Miles, J.W. Tidal Wave Diffraction by Channels and Bays. GEOPHYSICAL FLUID DYNAMICS, vol.5, p.155-171, 1973. (See annotation in Section I.)

Millero, F.J. The Physical Chemistry of Estuaries. Reprint from American Chemical Society Symposium Series, Marine Chemistry in the Coastal Environment, No.18, p.25-55, 1975. (See annotation in Section I.)

Moes, J. Stability of Small Estuary Mouths.. Proceedings, XVIth Congress of the International Association for Hydraulic Research, São Paulo, Brazil, July 27 to August 1, 1975, vol.I, Paper A11.

More than a hundred small estuary mouths are located along the South African Coast, many of which are unstable. Stable estuary mouths are important for the maintenance of the ecology of estuaries. Empirically developed stability criteria are mainly related to large inlets and are not suitable for stability investigations of small inlets. A numerical stability approach is presented, consisting of the following elements: (a) a one-dimensional implicit hydraulic mathematical model for a complete estuary, (b) computation of sediment transport in the littoral zone, resulting in deposition of sediments in the mouth, and calculation of scour due to tidal currents, (c) a combination of the hydraulic and the sedimentological factors in a mathematical model for inlet stability. References (6 items).

Muir, L.R. A One-Dimensional Tidal Model for Estuarine Networks. Hydrodynamics of Estuaries and Fjords; Proceedings of the 9th Liege Colloquim on Ocean Hydrodynamics, 1977, p.243-260.

This paper is concerned with one-dimensional numerical modelling of unsteady flow in networks of canals, rivers, and estuaries. The model will allow the computation of water elevation and velocity in any network of open channels to which the following assumptions are applicable: (1) flow is physically possible; (2) flow is entirely subcritical (i.e. the Froude number is less than 1.0); (3) flow is one-dimensional in space (i.e. laterally and vertically homogeneous); (4) appropriate boundary conditions are available; and (5) the section geometry of the channel is fixed (i.e. no deposition or scouring occurs). Flow in open channels can be described by two equations, one expressing the conservation of mass (the continuity equation) and one expressing the conservation of momentum in the longitudinal direction (the momentum equation). In general terms, these equations form a set of non-linear partial differential equations. Depending upon the assumptions made, there are various methods available for the solution of these equations; but, since the development of the digital computer, numerical methods have generally been used. This paper develops all of the theory necessary to construct a numerical model for simulating unsteady flow conditions in networks of open channels. The first section gives a formal method for describing the flow relationships in any network. The implicit

finite difference method is then described and extended for use in networks. The equations of motion are given, with a description of a generlized equation solver, and the properties of the finite difference scheme are discussed. The final section describes one of many applications of the numerical model to show that the method does work. References (8 items).

Murfee, G.W., Fruh, E.G., and Masch, F.D., Jr. Establishment of Operational Guidelines for Texas Coastal Zone Management: Interim Report on Estuarine Modeling. University of Texas at Austin, May 1973.

The estuarine modeling effort for this study has concentrated on the application of tidal hydrodynamic and water quality transport models to Corpus Christi Bay, Texas. The initial simulation work used existing hydrodynamic and salinity transport models of a system which included not only Corpus Christi but also Aransas to Copano Bays. Sensitivity tests were performed. In the hydrodynamic model, the response of tidal amplitudes and flows were determined for changes in roughness, wind stress coefficients, and evaporation rate. Water quality transport models which simulate the spatial distribution of biochemical oxygen demand; dissolved oxygen; total phosphorus; organic, ammonia, nitrite, and nitrate nitrogen are also under development. References (17 items).

Myers, V.A., and Overland, J.E. Storm Tide Frequencies for Cape Fear River. Journal of the Waterway, Port, Coastal and Ocean Division, Proc. ASCE, vol.103, No.WW4, p.519-535, November 1977.

Frequencies of storm tides, principally from hurricanes, in the Cape Fear River, North Carolina, below Wilmington are calculated by applying two previously developed numerical-hydrodynamic models to simulating surges from a large number of hypothetical hurricanes, chosen so as to collectively represent all climatologically expected hurricanes. The models are the continental shelf model of Jelesnianski and a model for the Cape Fear River by the writers. The recurrence interval of each hypothetical hurricane and its simulated tide is derived by combining the probabilities of the several parameters that define each storm. A methodology for carrying out the frequency evaluation economically is illustrated. The 100-yr return period tide level at Wilmington is estimated to be between 10 ft and 11 ft mean sea level. References (15 items).

Narayanan, M., and Shankar, N.J. A Numerical Model for the Simulation of Two-Dimensional Convective Dispersion in Shallow Estuaries. Paper presented at the International Symposium on Finite Element Methods in Flow Problems, edited by J.T. Oden, O.C. Zienkiewicz, R.H. Gallagher, and C. Taylor, The University of Alabama at Huntsville, 1974, p.455-458.

This paper presents a mathematical model for the simulation of short-term transport of a conservative constituent in a vertically well mixed estuary under the influence of hydrologic and tidal conditions. Attention is mainly focussed on the short-term temporal and spatial variations in the constituent concentration within a tidal cycle or over a short period of time.

Nasner, H. Prediction of the Height of Tidal Dunes in Estuaries. Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, Copenhagen, Denmark, vol.II, 1975, Chapter 60 (p.1036-1050). (See annotation in Section II.)

National Research Council, Geophysics of Estuaries Panel. Estuaries, Geophysics, and the Environment. National Academy of Sciences, Washington, D.C., 1977. (See annotation in Section IV.)

Nece, R.E., and Knoll, C.R. Flushing and Water Quality Characteristics of Small-Boat Marinas. Charles W. Harris Hydraulics Laboratory, University of Washington, Seattle, Technical Report No.40, June 1974. (See annotation in Section IV.)

Nece, R.E., and Lowthian, R.A. Tidal Circulation Study, Proposed Southeast Harbor Development. Charles W. Harris Hydraulics Laboratory, Department of Civil Engineering, University of Washington, Seattle, Technical Report No.47, January 1976.

This report presents the findings of a physical hydraulic model study performed to determine the effects on tidal currents near the mouth of the East Waterway of the Duwamish River estuary, Seattle, caused by modifications to piers in a proposed Southeast Harbor development. Most attention in the study was devoted to the behavior of the discharge plume from the East Waterway into Elliott Bay in order to provide hydraulic input into projections of the environmental impacts of the proposed Southeast Harbor development on the current and tidal regime in

the adjacent Elliott Bay and East Waterway areas; the disposition in these areas of sediments which would be associated with the dredge and fill operations during the construction phase would depend strongly on the behavior of the discharge plume. Tide current data from the model can be used in numerical water quality models such as one predicting sediment disposition. The present report does not extend to water quality predictions.

Nece, R.E., and Richey, E.P. Application of Physical Tidal Models in Harbor and Marina Design. Symposium on Modeling Techniques, 2nd Annual Symposium of the Waterways, Harbors and Coastal Engineering Division of ASCE, San Francisco, California, September 3-5, 1975, vol.I, p.783-801.

Small scale physical models are efficient, economical tools in the evaluation of designs for small harbors and enclosed marinas where quality problems associated with circulation and tidal exchange are important. Techniques used in such small models for determining flushing characteristics and internal circulation patterns of marinas are presented. The utility of various visual methods for information transfer to various agencies involved with the assessment of a project in its early design phases is discussed. Some generalized features relating planform geometry, tidal range, and entrance configurations to flushing and internal mixing characteristics based on model studies of six marinas, existing or proposed, in Puget Sound, Washington, are presented. The application of flushing data obtained from physical model studies to predictive water quality models in the evaluation of proposed designs is a desired result of the studies; one such coupling is presented. References (7 items).

Nece, R.E., Welch, E.B., and Reed, J.R. Flushing Criteria for Salt Water Marinas. Charles W. Harris Hydraulics Laboratory, University of Washington, Seattle, Technical Report No.42, June 1975. (See annotation in Section IV.)

Nerang River Entrance; A Mobile Bed Model. HYDRO DELFT, No.45, p.4-6, December 1976.

The main purpose of the model study was to recommend the most economical layout of training walls designed to achieve a stable entrance with a minimum depth of 4.5 m below Low Water Datum over a minimum width of 60 m. Other aspects to be studied were the methods for by-passing the longshore transport of sediment, and the consequences of construction of the walls in stages. The model has a horizontal scale of 1:200 and a vertical scale of 1:40. Part of the model was moulded in sand with a median diameter of 0.2 mm.

Nielsen, E. Feasibility of Coastal Morphological Models. Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, Copenhagen, Denmark, vol.II, 1975, Chapter 38 (p.663-684).

The paper deals with the initial ideas and concepts for development of a morphological model for a Delta coast, having particularly the Nile Delta in mind. The paper concentrates on the offshore zone, in which sediment is assumed primarily to be transported in suspension and during periods of sufficient agitation by the combined action of waves and ocean currents. In the Nile Delta great offshore changes take place due to the deprivation of the shelf area of Nile sediments by the closure of the Aswan High Dam, and serious nearshore long-range changes are expected to result from the changes to the offshore morphology. The modeling aids in establishing the mechanisms of the Delta shore, but the primary goal of the model is reliable prediction of future coastal changes. Fundamentally, the modeling is based on verification of the model - by trial and error - against known states of the model domain. Part A of the paper deals with the general concepts, while especially the entrainment of sediments is treated in Part B of the paper, yielding practical formulas for determining the threshold values for sediment entrainment by unidirectional flow and by wave action. References (15 items).

Niemeyer, G. Efficient Simulation of Nonlinear Steady Flow. Journal of the Hydraulics Division, Proceedings, ASCE, vol.105, No.HY3, p.185-195, March 1979.

Numerical simulation of steady flow can require considerable computation. However, unique features of finite element and finite difference methods can be exploited which lead to an efficient solution procedure. Although the resulting technique is fundamentally a time-stepping method, it achieves convergence within only a few steps. The considerable computational advantages of the method are obtained, moreover, without sacrificing the rigor of the governing equations, which are solved in their full nonlinear form. The technique is developed specifically for the vertically integrated Navier-Stokes equations. It is

applied to simulate steady river flow. References (12 items).

Niemeyer, G. Long Wave Model Independent of Stability Criteria. Journal of the Waterway, Port, Coastal and Ocean Division, Proceedings, ASCE, vol.105, No.WW1, p.51-65, February 1979.

Stability conditions for hydrodynamic models can be exceeded if the appropriate terms in the governing equations are approximated with implicit differences. If, in addition, the coefficient matrix for the resulting matrix equations is designed to be time invariant, an efficient simulation technique results. These features are exploited in a finite element-finite difference model of water circulation. The technique, which solves the vertically integrated Navier-Stokes equations, is used to simulate the circulation in a natural embayment where stability requirements for existing techniques would significantly restrict the size of the time step. References (26 items).

O'Connor, B.A. Sediment Intrusion in a Tidal Lock. Proceedings, XVIth Congress of the International Association for Hydraulic Research, São Paulo, Brazil, July 27 to August 1, 1975, vol.3, Paper C35.

The present paper describes modifications made to a two-dimensional mathematical model so that the dispersal of flocculated sediment can be described in tidal conditions. The modified model was also applied to a tidal flow involving density-exchange flow in Gladstone Lock on the Mersey Estuary (U.K.). The model results show that errors due to neglecting changes in water depth are generally less than 10%. The use of diffusion coefficients in the model which are based on observed velocity profiles and a theoretical shear stress distribution for a density-dominated flow produces a more uniform distribution of sediment with depth. However, concentration levels are generally lower than in earlier tests. Better model/prototype agreement could be obtained by adjusting model parameters but a lack of confirmatory field data prevents a check on the accuracy of such a process. Model tests with a particle fall velocity varying with depth indicate a more unifrom distribution of sediment with depth than when a constant value is used. There also appears to be few problems in using the model but a better description of the physical process is required. References (5 items).

O'Connor, B.A., and Zein, S. Numerical Modelling of Suspended Sediment. Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, Copenhagen, Denmark, vol.II, 1975, Chapter 65 (p.1109-1128).

The present paper describes the application of a two-dimensional numerical suspended sediment model to problems having analytical solutions, as well as to laboratory and field situations. The model is based upon an implicit finite-difference solution to a two-dimensional (longitudinal and vertical) diffusion-advection equation for suspended sediment transport. Horizontal eddy diffusion is neglected in comparison with vertical diffusion and vertical water motion is assumed negligible in comparison with the sediment fall velocity. The various applications indicate that the greatest errors in the model are due to large spatial concentration gradients and that errors can be controlled by a suitable choice of space and time step. In addition, it is considered that the model has great flexibility and seems to have an acceptable level of accuracy, at least in the field situations tested, provided the physical parameters of the model can also be determined accurately. References (16 items).

Ohlmeyer, F., and Berndt, D. Field and Model Data of Spreading in Estuaries. Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, Copenhagen, Denmark, vol.III, 1975, Chapter 137 (p.2357-2367).

Froudian tidal modeling besides two dimensional mathematical representation has proved to be a useful method to get information about the concentration levels of pollutants spreading into an area with tidal actions. The decay of non-conservative pollutants can be evaluated by using a decay curve. Distortion with scales of 1:500/1:100 and the use of special artificial roughness elements seem to counterbalance the effects of a differently turbulent diffusion in vertical and horizontal directions which is predicted by theory. The flow pattern in a model should be rough turbulent. References (2 items).

Olufeagba, B.J., Flake, R.H., and Armstrong, N.E. A Boundary Value Approach for Estuarine Water Quality Modelling with Results for Jamaica Bay, New York. ECOLOGICAL MODELLING, vol.1, No.1, p.3-30, May 1975.

Results of water quality modeling for Jamaica Bay, a New York estuary with a large hydraulic circulation, are presented. The two-dimensional topology is

approximated by a set of coupled one-dimensional subsystems. The long term steady state water quality problem is then reformulated as a multi-point boundary value problem for ordinary differential equations. Piecewise constant dispersion parameters are estimated from salinity data. A sequential algorithm based on parallel shooting is developed for solving the multi-point problem. The method, which simplifies handling of feedforward and feedback reaction kinetics, is equivalent to employing a high order finite difference technique with the subsequent enhanced accuracy. Results of model verification for uncoupled variables - salinity, coliform, total soluble phosphorus, and coupled variables for nitrogen (organic and ammonia) and BOD-DO for Jamaica Bay are discussed. References (37 items).

Ordonez, J.I. Modeling Sediment Deposition in a Tidal River. Symposium on Modeling Techniques, 2nd Annual Symposium of the Waterways, Harbors and Coastal Engineering Division of ASCE, San Francisco, California, September 3-5, 1975, vol.II, p.1347-1368.

A computer modeling technique was developed to study the extent and depth of sediment deposits in tidal rivers downstream from a local source of oversupply of sediment. The model describes the deposits as one dimensional deltas of uniform height moving in the flow direction according to the varying transport capacity of the river at different discharges and bed elevations. The model incorporates a reorganization of the hydraulic computations in the Einstein Method, for sediment transport calculations in alluvial rivers, to permit the determination of the sediment transport capacity of a given channel with a given discharge, when the depth or velocity in the reach are known. The new proceudre does not require a knowledge of the friction slope and is particularly suited for the computation of transport capacities in gradually varied unsteady flow where the hydraulic conditions can be represented by a series of uniform flows during discrete intervals of time. References (10 items).

Ouellet, Y., and Cerceau, J. Simulation of the Salinity Distribution in the St. Lawrence Estuary by a Two-Dimensional Mathematical Model. Symposium on Modeling Techniques, 2nd Annual Symposium of the Waterways, Harbors and Coastal Engineering Division of ASCE, San Francisco, California, September 3-5, 1975, vol.II, p.1249-1269.

Two numerical models have been developed, that is, a hydrodynamical model and a transport model, the former one serving as support to the latter one. It has been possible to obtain a better representation of the distribution of salinity concentration and to see the influence of the tide and Coriolis force on the penetration of salt water in the estuary. However, the two-dimensional approach has not made possible the differentiation between superficial fresh water flow and deep salt water flow, a most important aspect in sedimentation mechanisms. References (19 items).

Overland, J.E., and Myers, V.A. Model of Hurricane Tide in Cape Fear Estuary. Journal of the Waterways, Harbors and Coastal Engineering Division, Proc. ASCE, vol.102, No.WW4, p.407-424, November 1976.

A quasi one-dimensional numerical-hydrodynamic model of storm surge in the Cape Fear River, North Carolina, is formulated as an aid in determining storm tide frequencies. Separate momentum balances are maintained for the main channel and the adjacent shallows. Input at the ocean is specified from a hydrograph computed from Jelesnianski's storm surge model, SPLASH, linearly combined with the astronomical tide. Verification was made for the astronomical tides and hurricanes Hazel, Diane, and Helene. Significant interaction between the hurricane surge and astronomical tide is indicated. Storm data indicate that wind speeds over the upper portion of the estuary should be reduced to 0.7 of the open ocean values. Estimation of storm tide frequencies using this model is presented in a forthcoming paper by the writers. References (13 items).

Parker, R. A. Spatial Patterns in a Nutrient Model. ECOLOGICAL MODELLING, vol.4, No.4, p.361-370, May 1978. (See annotation in Section II.)

Partheniades, E. Unified View of Wash Load and Bed Material Load. Journal of the Hydraulics Division, Proc. ASCE, vol.103, No.HY9, p.1037-1057, September 1977.

The paper presents a new generalized model of flow-sediment interaction. The behavior of the wash load and of the suspended bed-material load can then result as special cases of the new model. The latter follows the lines of Einstein's original probabilistic model except that interparticle forces of mechanical and

physico-chemical nature have been introduced and that the flow-induced forces on the individual grains or flocs were assumed to have an upper and lower bound. It is shown that the actual wash load may consist of two distinct types of sediment which may coexist (a) Bed load function for a limited range of flow conditions whereas above that range it behaves as a wash load; and (b) the other never has a bed load function. It is shown that the latter consists predominantly of silt and clay, i.e., of sediment finer than 0.06 mm, a fact consistently observed in alluvial channels. References (11 items).

Partridge, P.W., and Brebbia, C.A. Quadratic Finite Elements in Shallow Water Problems. Journal of the Hydraulics Division, Proc. ASCE, vol.102, No.HY9, p.1299-1313, September 1976.

Two quadratic finite element models of the shallow water equations are presented, one using an explicit fourth-order Runge Kutta time integration scheme, the other an implicit trapezoidal rule scheme. The models are applied to rectangular channel problems which are similar to the tidal behavior of an estuary. Stability, accuracy, and the influence on the results of the friction and advective terms are covered. Bottom topography is shown to influence the results by changing the nature of the wave in the channel. Advective terms should be included in the model if there is significant bottom slope. In real situations the model is started with the water still and the surface flat, i.e., the "cold start." In the frictionless situation, this produces spurious wave forms related to the natural frequencies of the channel. These may be damped out by the specification of a high level of friction. References (8 items).

Pearce, B.R., and Christodoulou, G.C. Application for a Finite Element Dispersion Model for Coastal Waters. Proceedings, XVIth Congress of the International Association for Hydraulic Research, São Paulo, Brazil, July 27 to August 1, 1975, vol 1, Paper A4.

A two-dimensional, vertically integrated, numerical model for the dispersion of pollutants in coastal areas is briefly presented. The finite element technique is used, allowing flexibility in the description of geometry, boundary conditions, sources and sinks; the velocity field, dispersion and decay coefficients may vary with space and time. The model is applied to a large scale sediment dispersion experiment carried out in Massacusetts Bay in June 1973. The necessary velocity input is obtained through a finite element two-dimensional circulation model run under the appropriate meteorological conditions. The dispersion and decay coefficients and the boundary conditions used are discussed. The results show the plume moving to the SE, mostly close to the shoreline. The agreement to field measurements is satisfactory. References (4 items).

Pearson, C.E., and Winter, D.F. Computation of Tidal Flow in Well-Mixed Estuaries. Journal of the Hydraulics Division, Proc. ASCE, vol.102, No.HY3, p.367-377, March 1976. (See annotation in Section I.)

Pearson, C.R., and Carter, L. The Application of Simple Models for the Prediction of Effluent Dispersal in Estuaries. EFFLUENT AND WATER TREATMENT JOURNAL, vol.12, No.9, p.472-474, September 1972 (See annotation in Section IV.)

Pedersen, F.B. Gradually Varying Two-Layer Stratified Flow in Fjords. International Symposium on Stratified Flows, Novosibirsk (U.S.S.R.), 1972, Paper 19. (See annotation in Section III.)

Perrels, P.A.J., and Karelse, M. A Two-Dimensional Model for Salt Intrusion in Estuaries. Hydrodynamics of Estuaries and Fjords; Proceedings of the 9th Liege Colloquium on Ocean Hydrodynamics, 1977, p.107-125.

A two-dimensional laterally integrated numerical model has been developed to represent the vertical velocity and salinity distribution along an estuary. The governing equations which express the conservation of mass, momentum and salt content, are solved by a finite difference method in combination with a splitting technique. The model has been applied to the Delft tidal salinity flume, which may be considred as a two-dimensional tidal flow characteristic for estuaries such as the Rotterdam Waterway. By this application several assumptions about the effect of stratification on the vertical diffusion were tested. Preliminary reults of the comparison of computed and measured data will be shown in the paper. References (24 items).

Pickrill, R.A. Effects of Boat Wakes on the Shoreline of Lake Manapouri. NEW ZEALAND ENGINEERING, vol.33, No.9, p.194-198, September 1978.

Lake Manapouri has a low energy wave climate and waves generated artificially by boats may contain higher energies. The regular passage of boats may modify the wave climate to the extent that, on a potentially unstable shoreline such as occurs around Manpouri, this may have permanent effects on beach stability. Manapouri is a large lake and the implications for beach stability on lakes and harbours in other restricted fetch situations are outlined. References (10 items).

Pinless, S.J. The Reduction of Artificial Boundary Reflections in Numerically Modelled Estuaries. The Institution of Civil Engineers, Proceedings, vol.59, Part 2, p.255-264, June 1975.

The tidal input at the seaward boundary of a model of an estuary is controlled to conform to the existing tidal curves. If the model is used to investigate the effects of major physical changes in the estuary it will ignore any effect these changes have on water levels at the model's boundary. This difficulty can be overcome by siting the model boundary sufficiently far from the source of any disturbance in the estuary as to be unaffected by it. Since observed data are not always available for input at a suitable boundary, a method has been developed of computing input for the numerical model from observations at a tide gauge within the estuary. This method of seaward extension of a one-dimensional numerical model is described together with results from its use. References (5 items).

Pitts, F.H., and Farmer, R.C. A Three-Dimensional, Time-Dependent Model of Mobile Bay. Final Report. Louisiana State University, Baton Rouge, Department of Chemical Engineering, October 1976. 444p.

A three-dimensional, time-variant mathematical model for momentum and mass transport in estuaries was developed and its solution implemented on a digital computer. The mathematical model is based on state and conservation equations applied to turbulent flow of a two-component, incompressible fluid having a free surface. Thus, buoyancy effects caused by density differences between the fresh and salt water, inertia from the river and tidal currents, and differences in hydrostatic head are taken into account. The conservation equations, which are partial differential equations, are solved numerically by an explicit, one-step finite difference scheme and the solutions displayed numerically and graphically. To test the validity of the model, a specific estuary for which scaled model and experimental field data are available, Mobile Bay, was simulated. Comparisons of velocity, salinity and water level data show that the model is valid and a viable means of simulating the hydrodynamics and mass transport in means of simulating the hydrodynamics and mass transport in non-idealized estuaries. References (50 items).

Pollock, T.J., Hinwood, J.B., O'Brien, W.T., et al. Calibration Data for a Numerical Hydrodynamic Model. Fifth Australasian Conference on Hydraulics and Fluid Mechanics, University of Canterbury, Christchurch, New Zealand, 9-13 December 1974; Conference Proceedings, vol.II, p.276-283. (See annotation in Section VII.)

Ponce, V.M., Garcia, J.L., and Simmons, D.B. Modeling Alluvial Channel Bed Transients. Journal of the Hydraulics Division, ASCE, vol.105, No.HY3, p.245-256, March 1979.

A mathematical model is developed to simulate bed transient formation and propagation in alluvial channels. The model is of the known-discharge type, i.e., within one time step, the water discharge is considered steady. This technique allows for the implicit numerical modeling of bed transient propagation using longer time steps that would otherwise be possible using the conventional sequential routing method. Instability due to ill-posing of the sediment transport function is circumvented by using a power relation between bed material transport and mean flow velocity. Errors in mass conservation due to linearization at the boundary are eliminated by using a nonlinear formulation of the upstream boundary condition. References (10 items).

Ponce, V.M., Indlekofer, H., and Simmons, D.B. Convergence of Implicit Bed Transient Models. Journal of the Hydraulics Division, Proceedings, ASCE, vol.105, No.HY4, p.351-363, April 1979.

A comprehensive theoretical treatment of the convergence of the four-point implicit numerical model of alluvial channel bed transients is presented. The dimensionless celerity and logarithmic decrement of the analytical and numerical solutions are calculated. Convergence is tested by establishing the ratio of celerities (translation convergence) and the ratio of attenuation factors (attenuation convergence). Two physical and

three numerical parameters are identified: the equilibrium flow Froude number, the transient flow dimensionless wave number, the spatial resolution, the Courant number, and the weighting factor of the scheme. References (8 items).

Prandle, D. A Numerical Model of the Southern North Sea and River Thames. Institute of Oceanographic Sciences, Bidston Observatory, Birkenhead, Cheshire, Report No.4, 1974.

The model simulates the propagation of tides and storm surges in the southern North Sea and River Thames. It consists of two parts dynamically interfaced, a one-dimensional representation of the River Thames together with a two-dimensional representation of that part of the North Sea south of latitude 53° 20', and that part of the English Channel east of the Greenwich meridian. The objective is to predict tidal elevations, up to six hours in advance, for use as input to the control program governing the operation of the Thames barrier. The model requires the specification of tidal elevations along the seaward boundaries; values from tidal charts are used in the present examples. Tidal charts for the M_2 constiuent published by both the Admiralty and the German naval authorities are compared with the corresponding charts computed by the model. For two periods, each of three days duration, comparisons were made between elevations from the model, tide gauge recordings and tidal predictions at 31 stations within the area. The periods chosen were meteorologically quiet and the results demonstrated that, under these conditions, the computed tidal heights in the model were generally within 0.35 m of recordings with a maximum discrepancy of 0.8 m. The development of the model will include some refinement as better observational data become available. The eventual mode of operation is visualized under one or both of the following conditions:-(i) as an independent system with boundary conditions specified from actual recordings and (ii) as part of a system simulating the whole of the North Sea with boundary conditions specified from a larger model (interactively or otherwise).

Prandle, D. Storm Surges in the Southern North Sea and River Thames. Proceedings of the Royal Society of London, Series A, Mathematical and Physical Sciences, vol.344, p.509-539, August 12, 1975.

A numerical model has been formulated to provide predictions of surge levels in the southern North Sea and River Thames. The model has been used to simulate the diastrous surge of January-February 1953. It is shown that the major surge component along the east coast of England was that propagating from the northern North Sea, whereas along the Dutch coast the major component was due to the wind effect over the southern North Sea. During the course of the storm there was a large net transport of water southwards through the Dover Strait. This residual flow was found to affect the surge levels at Southend. An investigation has been made of the effect of deploying the future Thames Barrier during the course of the storm. At Southend the amplitude of the reflected wave from the barrier was found to be negligible. The distribution of energy during the storm has been examined and a plot made of the spatial variation in energy dissipation by bed friction. References (17 items).

Prandle, D., and Wolf, J. Surge-Tide Interaction in the Southern North Sea. Hydrodynamics of Estuaries and Fjords; Proceedings of the 9th Liege Colloquium on Ocean Hydrodynamics, 1977, p.161-185.

Observations of storm surges in the River Thames show that surge peaks tend to occur on the rising tide and seldom, if ever, occur on high tide. This tendency has been attributed to the interaction between tide and surge propagation as described by the non-linear terms in the associated hydrodynamic equations. A recent study by Prandle and Wolf examined the mechanics of interaction within the River Thames and showed that an important component of it originates outside of the river; this component is investigated in the present paper. A method of identifying interaction in the southern North Sea is developed involving the use of two hydrodynamic numerical models, one simulating tidal propagation and the other surge propagation. Operating these models concurrently, the coupling between tide and surge is introduced by perturbation terms which represent the influence in either model of sea levels and velocities computed by the other. This approach has been used to simulate the pattern of interaction which occurred during the disastrous storm surge of 30 January to 2 February 1953. It is shown that interaction in the southern North Sea results primarily from the quadratic friction term, developing significantly in the coastal region off Lowestoft as far south as the Thames estuary due to the high velocities associated with both tide and surge propagation in that area. Changes in the surface elevation of tide and surge due to the effects of interaction may develop rapidly in certain localized

regions such as the Thames estuary. There may also be longer period changes of the order of the duration of the storm due to a systematic dispalcement of the M_2 tidal regime. References (5 items).

Protecting Canal Banks Against the Effects of Passing Ships. HYDRO DELFT, No.41, p.2-7, November 1975. (See annotation in Section V.)

Prych, E.A., and Haushild, W.L. Water Quality Model of a Salt-Wedge Estuary. Symposium on Modeling Techniques, 2nd Annual Symposium of the Waterways, Harbors and Coastal Engineering Division of ASCE, San Francisco, California, September 3-5, 1975, vol.II, p.1138-1155.

A numerical model has been developed and used to calculate salinity, temperature, chlorophyll a (phytoplankton) concentration, biochemical oxygen demand, and dissolved-oxygen concentration in the Duwamish River estuary, Washington. In the model, the estuary is divided vertically into the wedge and the upper layer; the latter is divided into three sublayers. Longitudinally, the estuary is divided into about 35 segments; laterally, the estuary is assumed to be homogeneous. The wedge model is Lagrangian, and the upper-layer model is Eulerian in a coordinate system that moves with the fluid in the wedge. All velocities are computed using conservation-of-volume equations, observed data, and tide stages. The fluid-transport processes modeled are longitudinal advection and dispersion in the wedge; entrainment from the wedge to the upper layer; and longitudinal advection, vertical advection, and vertical diffusion in the upper layer. Biochemical and other physical processes that affect the constituent concentrations are also simulated. The computed concentrations agreed reasonably well with observed data. References (9 items).

Prych, E.A., Haushild, W.L., and Stoner, J.D. Numerical Model of the Salt-Wedge Reach of the Duwamish River Estuary, King County, Washington. U.S. Geological Survey Professional Paper 990, 1976

A numerical model of a salt-wedge estuary developed by Fischer (1974) has been expanded and used to calculate the distributions of salinity, temperature, chlorophyll a concentration, biochemical oxygen demand, and dissolved-oxygen concentration in the Duwamish River estuary, King County, Wash. With this model, which was calibrated and verified with observed data, computed temperatures usually agreed within 2° Celsius of observed temperatures. The model was used to predict the dissolved-oxygen concentrations in the Duwamish River estuary when the Renton Treatment Plant sewage-effluent discharge is increased to its proposed maximum of 223 cubic feet per second (6.31 cubic meters per second). The computed monthly average dissolved-oxygen concentrations in the estuary decreased by a maximum of 2 milligrams per liter when compared with computations for the summer of 1971, when the effluent discharge averaged 37 cubic feet per second (1.05 cubic meters per second). The increase in effluent discharge is not expected to cause large changes in phytoplankton concentrations in the estuary. References (53 items).

Quetin, B. The Effect of Wind on Currents and Diffusion in Coastal Sea Areas. Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, Copenhagen, Denmark, vol.III, 1975, Chapter 140 (p.2391-2400). (See annotation in Section I.)

Ramming, H.-G. Numerical Investigations of the Influence of Coastal Structures upon the Dynamic Off-Shore Process by Application of a Nested Tidal Model. Hydrodynamics of Estuaries and Fjords; Proceedings of the 9th Liege Colloquium on Ocean Hydrodynamics, 1977, p.315-348.

By application of a tidal North Sea model with high resolution in coastal areas, several numerical investigations were carried out dealing with predictions on dynamical processes in off-shore shallow-water regions as subsequence of structural measures. One of these investigation series and their results are presented and discussed. The subject deals with the effect of the structural change of an existing breakwater and about the effect of a wash-up of a sand deposit in the shoal area upon the water levels, velocities, tidal residual currents and the mean transports of one tidal cycle in the off-shore range. The size of the investigation area is determined by the approximate effect in the remote region. Here it must be ensured that the boundary conditions of the selected part area obtained from the nested North Sea model will not be influenced by the structural changes. The smallest mesh size of the applied model is 51 m. The areas of a differing mesh size are an interaction to each other. In the course of the article certain technical, practical details of the numerical treatment of the dynamic processes in shallow water with a very complex morphology will be stated so as used by the author. Numerical models are only one possibility for prognosticating

alteration tendencies after structural measures in the coastal area. Numerical models have certainly great advantages in comparison to other investigation methods, but they also have their limits, however, which should not be misunderstood. The obtained results must be particularly critical evaluated in respect of their physical importance. The numerical investigations exclude a simultaneous assertion about a possible transport of solids since it was started from an unchangeable morphology apart from structural measures given into the model. Therefore, only forecasting for short periods of time will be possible. Long-time approximations with the aid of numerically determined residual currents and their alterations are only conditionally permissible. References (12 items).

Read, A.L. Hydraulic Aspects of the West Lakes Development. Civil Engineering Transactions, The Institution of Engineers, Australia, vol.CE15, Nos.1&2, p.11-13, 26, 1973. (See annotation in Section III.)

Ree, W.J. van de, and Schaap, H.Y. Measured Contributions of the Terms of the Vertically Integrated Hydrodynamic Equations. Symposium on Modeling Techniques, 2nd Annual Symposium of the Waterways, Harbors and Coastal Engineering Division of ASCE, San Francisco, California, September 3-5, 1975, vol.II, p.1237-1248.

In engineering studies for the Delta project, two-dimensional tidal computations are used in conjunction with hydraulic models for the prediction of tide levels and currents in the estuaries of the Rhine and Scheldt and adjacent sections of the Southern North Sea. A detailed field survey of tide levels and currents near Goeree, which was made to assess changes in tide levels and currents as a result of the closure of one of the branches of the Rhine estuary, made it possible to compute the time histories of all terms of the momentum equation at a few locations. During the survey, simultaneous current measurements were made at 16 stations over a 13-hour period. The velocities and directions were measured in the vertical at several locations. From this data the vertically-averaged velocities and directions were computed. In addition, at a large number of stations the tide levels were measured. Also, float measurements were made. From the analysis of this data it can be concluded that in hydraulic models of areas with flow conditions similar to those investigated, and at the same latitude, the effect of the earth's rotation should be simulated. If two-dimensional tidal computations of such areas are made, the advection terms should not be neglected in the computation, as the contribution of these terms is significant in the determination of the flow field. References (2 items).

Rees, A.J. van. Experimental Results on Exchange Coefficients for Non-homogeneous Flow. Delft Hydraulics Laboratory Publication No.150, November 1975. Same in: Proceedings, XVIth Congress of the International Association for Hydraulic Research, São Paulo, Brazil, July 27 to August 1, 1975, vol.3, Paper C36.

To get an insight into the salinity intrusion phenomena in the Rotterdam Waterway Estuary, a research program on density currents is being carried out in a tidal flume. Data from a series of tests have been evaluated on the basis of a two-dimensional analysis, applied for control volumes in a detailed sampling system. As a result, the distribution of the turbulent exchange of mass and momentum could be determined. These quantities have been analyzed in detail on the basis of some relevant theories, e.g., diffusion and mixing length theories. Attempts have been made to correlate the physical quantities used in these theories with parameters related to the geometry and the flow conditions. References (5 items).

Reichard, R.P., and Clikkol, B. Application of a Finite Element Hydrodynamic Model to the Great Bay Estuary System, New Hampshire, U.S.A. Hydrodynamics of Estuaries and Fjords; Proceedings of the 9th Liege Colloquium on Ocean Hydrodynamics, 1977, p.349-372.

A vertically integrated, one layer, hydrodynamic model developed by Connor and Wang for Massachusetts Bay has been adapted to the Great Bay Estuary, New Hampshire. This finite element model was found to be well suited to the complexities of the estuary. Initial model development and testing was carried out. The bottom friction coefficient was the dominant parameter in the calibration process. A method for selection of the bottom friction coefficient in the calibration process was developed. Eddy viscosity terms, which primarily act as numerical damping, were included. The model was calibrated using an extensive set of tidal sea level and current data recently collected by the University of New Hampshire and the National Ocean Survey (NOS). The data sets used in the calibration and validation process

include sea level data used to specify open boundary conditions in the model. Validation results show good agreement between tidal elevation measurements and model predictions. Predicted currents have a different scale of resolution than the current measurements, making direct comparisons difficult to interpret. A program for processing current data to make more meaningful comparisons is presented briefly. References (9 items).

Reid, R.O., and Whitaker, R.E. Wind-Driven Flow of Water Influenced by a Canopy. Journal of the Waterways, Harbors and Coastal Engineering Division, Proc. ASCE, vol.102, No.WW1, p.61-77, February 1976. (See annotation in Section I.)

Richey, E.P., and Nece, R.E. Flushing and Mixing Characteristics, East Bay Small Boat Basin. Charles W. Harris Hydraulics Laboratory, University of Washington, Seattle, Technical Report No.50, July 1977.

The objective of the model study is to assess the flushing and mixing characteristics of alternative plans and design recommendations for the proposed East Bay marina with the end point being an input to the assessment of the water quality parameters within the marina and the adjacent waters. The pertinent scales in the model are: Horizontal 1 to 480; Vertical, 1 to 48; Velocity, 1 to $\sqrt{48}$; Time, 1 to $\frac{\sqrt{48}}{480} = 69.28$; Tidal period in model 10.76 minutes. The drogue measurements were used to verify currents in the model. The effect of the shoal water off Ellis Creek was duplicated by building up a ridge in the model until representative current patterns developed. List of References (15 items).

Rijkswaterstaat, Delft University of Technology, and Delft Hydraulics Laboratory, The Netherlands. Salt Distribution in Estuaries; Proceedings of a Seminar held in 1974, by authors of Rijkswaterstaat, Delft University of Technology, and Delft Hydraulics Laboratory, The Hague, The Netherlands. Rijkswaterstaat Communications No.26 and Delft Hydraulics Laboratory Publication No.169, 1976. (See annotation in Section III.)

Robinson, I.S. Tidal Response of a Wedge-Shaped Estuary to the Installation of a Tidal Power Barrage: A Simplified Approach. INSTITUTION OF CIVIL ENGINEERS, PROCEEDINGS, Part 2, vol.65, p.773-790, December 1978.

A linear, frictionless analytic model of single frequency tidal oscillations in a wedge-shaped estuary (having depth and width decreasing linearly to the head) is presented and applied to the Bristol Channel. It is shown that the introduction of a solid or permeable barrage can be modelled and an expression can be obtained for the power available from a particular barrier design. This enables a first approximation to the optimum design of barrier flow characteristics to be obtained by analysis rather than by costly numerical modelling experiments. It is shown how the model can also be used to calculate gap velocities during the closure of the barrage at the time of construction. References (13 items).

Runchal, A.K. Numerical Model for Storm Surge and Tidal Run-Up Studies. Symposium on Modeling Techniques, 2nd Annual Symposium of the Waterways, Harbors and Coastal Engineering Division of ASCE, San Francisco, California, September 3-5, 1975, vol.II, p.1516-1534.

The mathematical and numerical basis of a computational model developed for study of run-up and draw-down on tidal flats is described herein. The model is based upon the "shallow water" theory and accounts for the presence of Coriolis force, basin friction, wind stresses and pressure gradients. The mathematical model is pseudo-two-dimensional in nature in that the gradients of the variables are assumed negligible in a direction normal to that of the main concern; the resulting algorithm is especially efficient and economical. Unlike many other numerical algorithms the present one is found to be especially suited for preserving the characteristic wave speeds and amplitudes of the solution. It has been tested with a number of trial problems and found to provide results which accord well with the available approximate or analytic solutions. References (10 items).

Sager, G. Spatial Interpolation of Tidal Streams (Flachenhafte Interpolation bei Gezeitenstromen). British Library Lending Division, RTS 10485, January 1977.

Arising from the importance of tidal streams for navigation different formulae are developed for the spatial interpolation of stream velocities and directions. The results obtained from the different methods are compared for the critical example of the area south of Portland Bill. The natural distribution of stream data

in this area is available from earlier investigations by the author and is used for the evaluation of the formulae in this rather unfavourable case. References (5 items).

Sager, R.A., and Seabergh, W.C. Modeling Sediment Movement for Masonboro Inlet. Symposium on Modeling Techniques, 2nd Annual Symposium of the Waterways, Harbors and Coastal Engineering Division of ASCE, San Francisco, California, September 3-5, 1975, vol.I, p.27-293.

As part of a U.S. Army Corps of Engineers research program, the General Investigation of Tidal Inlets, a study of Masonboro Inlet is being conducted in a distorted scale, fixed-bed model at the U.S. Army Engineer Waterways Experiment Station in Vicksburg, Mississippi. The study involves an examination of fixed-bed modeling techniques for inlets. One phase of the Masonboro Inlet study is to determine methods of simulating sand movement in and around the inlet. Effective procedures for predicting sand movement would provide a valuable aid in considering the effects of planned improvements to an inlet. Masonboro Inlet is a naturally occurring entrance through a sandy barrier beach along the North Carolina coast. It has a single weir-type jetty constructed in 1965-1966 with a deposition basin dredged adjacent to the weir and a navigation channel dredged through the ocean bar. The project functioned effectively for a year, then the channel relocated near the jetty and cut through the deposition basin. In 1969, velocities, tidal heights, and other data were collected from the prototype in order to verify a fixed-bed model. After hydraulic verification, the model was verified for shoaling patterns. The shoaling verification involved a trial-and-error process of finding the right material, wave climate, and hydraulic conditions to reproduce the shoaling trends for a 2-yr period in the prototype. The shoaling trends were verified for the 1969-1971 period using a lightweight plastic cube, 3 mm on a side, and with a specific gravity of 1.18. After verification the model bed was molded to conform to the 1964 preproject conditions and a test was made to see if the model would predict the shoaling trends that occurred in the prototype after construction of the project. Results of the model tests compared to prototype data showed a good agreement between the model and prototype. References (7 items).

Sager, R.A., and Seabergh, W.C. Physical Model Simulation of the Hydraulics of Masonboro Inlet, North Carolina. U.S. Army Corps of Engineers, General Investigation of Tidal Inlets, GITI Report 15, November 1977.

The report is part of the General Investigation of Tidal Inlets 'Inlet Hydraulic Study.' The study involves the investigation of the tide- and wave-generated flow regime and water-level fluctuations in the vicinity of coastal inlets. Masonboro Inlet was selected as an inlet to be used in determining the usefulness and reliability of physical and mathematical models in predicting hydraulic characteristics of inlet/bay systems. The report presents results obtained from the physical model study. The Masonboro Inlet fixed-bed model, constructed to scales of 1:300 horizontally and 1:60 vertically, reproduced an area extending to the -45 ft contour in the Atlantic Ocean and to the nodal points in each interior channel. The wetlands were accurately reproduced near the inlet; but those areas farther bayward, being relatively flat, were reproduced schematically and artificially bent into the research flume to provide storage for the tidal prism. The model was equipped with appurtenances necessary for accurate reproduction and measurement of tides, tidal currents, waves, and other significant prototype phenomena. Model verification tests assured that the model hydraulic regimen was in satisfactory agreement with that of the prototype. Five velocity ranges with three stations at each range were verified in the model (readings were taken at three depths at each station); and seven tidal elevation gages in the ocean and bay were also verified.

Salas, H.J., and Thomann, R.V. A Steady-State Phytoplankton Model of Chesapeake Bay. JOURNAL, Water Pollution Control Federation, vol.50, No.12, p.2752-2770, December 1978. (See annotation in Section I.)

Sanmuganathan, K., and Abernethy, C.L. A Mathematical Model to Predict Long Term Salinity Intrusion in Estuaries. Reprint from Proceedings Second World Congress, International Water Resources Association, New Delhi, vol.III, p.313-324, December 1975. (See annotation in Section III.)

Schaffranek, R.W., and Baltzer, R.A. Compiling Bathymetry for Flow Simulation Models. Symposium on Modeling Techniques, 2nd Annual Symposium of the Waterways, Harbors and Coastal Engineering Division of ASCE, San Francisco, California, vol.II, September 3-5, 1975, p.1329-1346. (See annotation in Section VII.)

Schofield, W.R., and Krutchkoff, R.G. Deterministic Model of Dynamic Eutrophic Estuary. Journal of Environmental Engineering Division, Proc. ASCE, vol.100, No.EE4, p.979-996, August 1974. (See annotation in Section I.)

Schofield, W.R., and Krutchkoff, R.G. Stochastic Model of Dynamic Eutrophic Estuary. Journal of the Environmental Engineering Division, Proc. ASCE, No.EE3, p.613-628, June 1974.

A stochastic model for a one-dimensional estuary has been formulated. It was found that with the addition of a single new parameter, a stochastic model can be built from its deterministic counterpart. The derivation was sufficiently general to permit any number of components and any reasonable system configuration to be handled. All system parameters, conditions, and forcing functions could be continuous functions of time (not just tidal phase), position, and if necessary, other factors. Due to space limitations the deterministic model used could not be analyzed but will be presented later in a second article. The Potomac estuary was modeled for the period January-October 1969. Measured and predicted concentrations were compared in their means and in the distributions with good agreement. The use of this model for modeling other estuaries is recommended. References (23 items).

Schrøder, H., Mortenson, P., and Dahl-Madsen, K.I. Mathematical Modelling of Thermal Pollution in an Estuary. Proceedings, XVIth Congress of the International Association for Hydraulic Research, São Paulo, Brazil, July 27 to August 1, 1975, vol.4, Paper D23.

Power plants with once-through cooling water system situated at estuaries may give rise to a permenent build-up of excess temperatures throughout the estuary. Planning of the layout of the cooling water system requires reliable predictions of recirculation and biological impact on the aquatic environment as a consequence of increased temperatures. Segmented mathematical models based on measurements undertaken in the prototytpe are found to be an extremely useful tool for the hydraulic as well as the environmental engineer. As an example, a one-dimensional model for prediction of excess temperatures and primary production is treated, and results from an investigation of a Danish estuary are presented. References (3 items).

Schubel, J.R., and Carter, H.H. Suspended Sediment Budget for Chesapeake Bay. Estuarine Processes; Volume II, Circulation, Sediments, and Transfer of Material in the Estuary, edited by Martin Wiley. New York, Academic Press, 1977, p.48-62. (See annotation in Section II.)

Seaburgh, W.C. Simulation of Sediment Movement for Masonboro Inlet, North Carolina. In: Estuarine Research, Volume II: Geology and Engineering, edited by L. Eugene Cronin, Academic Press, Inc., New York, 1975, p.111-127.

Paper presented at the Second International Estuarine Research Conference, held by the U.S. Estuarine Research Federation at Myrtle Beach, South Carolina, 15-17 October 1973. Under a Corps of Engineers research program, the General Investigation of Tidal Inlets, a fixed-bed model study of the inlet is under way. This model had a dual purpose: first, it would be a design tool to find solutions to problems at the inlet; second, it would be an investigative tool, used to determine whether a model could find the causes of the problem at the inlet and whether a model study could have aided in the prevention of the shifting channel. As a part of the program to meet these purposes, sediment movement on the bar and near the inlet was simulated. The model was constructed to a horizontal scale of 1:300 and a vertical scale of 1:60. Prototype velocity and tidal height at the inlet were measured. In a process called "verification," the model was adjusted by trial and error to reproduce those data. The hydraulic verification indicated that the vertical and horizontal water measurements were in agreement with the prototype and that the velocity distributions of the prototype were reproduced in the model.

Seabergh, W.C., and Mason, C. Masonboro Inlet Fixed-Bed Model Evaluation. Symposium on Modeling Techniques, 2nd Annual Symposium of the Waterways, Harbors and Coastal Engineering Division of ASCE, San Francisco, California, September 3-5, 1975, vol.I, p.294-314.

An evaluation of state-of-the-art tidal inlet hydraulic model procedures was performed by the Coastal Engineering Research Center and the Waterways Experiment Station (WES) to determine the usefulness and reliability of a physical model to accurately predict the hydraulic characteristics of an inlet-bay system. Masonboro Inlet, a single-jettied inlet

on the North Carolina coast was selected as the prototype. The Masonboro Inlet tidal model was constructed at WES to scales of 1:300 horizontally and 1:60 vertically. Model calibration tests assured that the model tidal heights and velocities were in agreement with those of the prototype 1969 conditions. To evaluate the model's predictive capability under different conditions an additional set of hydraulic data was collected in July 1974, after the inlet thalweg had migrated further northward against the jetty. Tidal heights, velocities, and surface flow patterns using dye streaks were obtained in the prototype. The model was remolded to the 1974 bathymetry, and data were collected at identical locations as in the prototype. Using the same roughness distribution as the verified 1969 condition, velocity and tides were shifted one-half hour due to too much roughness at the entrance because of the narrower but deeper cross section. Model bay tide ranges were 11% less than the prototype and velocities averaged 0.6 ft/sec different than prototype, although the average difference in maximum velocities was only 0.3 ft/sec. Model dye streak patterns showed good agreement with the prototype when wind waves were reproduced, better than a non-wave condition. Also wave reproduction improved model-prototype velocity comparisons at the inlet entrance. References (3 items).

Shankar, N.J. Influence of Tidal Inlets on Salinity in Estuaries. Journal of the Waterways, Harbors and Coastal Engineering Division, Proc. ASCE, vol.101, No.WW4, p.369-383, November 1975.

The paper outlines mathematical hydrodynamic and salinity transport models applicable to the analysis of the effects of tidal inlets on shallow irregularly shaped estuaries typical of the Gulf Coast of the United States of America. The practical utility of these models has been developed and demonstrated for the simulation of salinity distributions under well-mixed water conditions for two estuaries on the Gulf Coast. Specifically, Matagorda Bay, Texas, is used to verify the salinity distribution model. Comparison between the computed concentrations and ground truth data is found to be excellent. Galveston Bay, Texas, is used to demonstrate the effects of a tidal inlet on salinity distribution. Comparison with the existing data indicates good qualitative agreement. The effects of tidal inlet are found to be mainly localized for the case considered. References (21 items).

Shankar, N.J., and Narayanan, M. Conservative Transport Models for Shallow Estuaries. In: Proceedings, Forty-Fourth Annual Research Session, Chandigarh, 29 January - 1 February 1975, Volume II - Hydraulics. Central Board of Irrigation and Power (India), Publication No.123, January 1975, p.134-144.

This paper describes two-dimensional mathematical models for the simulation of short-term and long-term variations of concentrations of a conservative constituent in a well-mixed shallow estuary. The application of the short-term transport model is demonstrated for slug and continuous releases of conservative material in Matagorda Bay, Texas. The sensitivity of the short-term transport model to vaying magnitudes of dispersion coefficient is also presented. The long-term model is also applied to Matagorda Bay for simulating salinity distribution in the bay. The computed distribution is compared with the prototype measurements and the agreement is found to be excellent. References (13 items).

Shearin, K.K., and Machemehl, J.L. River Delta Computer Simulation Model (SIMUDELT). Symposium on Modeling Techniques, 2nd Annual Symposium of the Waterways, Harbors and Coastal Division of ASCE, San Francisco, California, September 3-5, 1975, vol.1, p.240-253.

Bonham-Carter and Sutherland (1968) published DELTASIM, a FORTRAN IV program which simulates the formulation of a subaqueous delta where a fresh water stream discharges into a saline basin, but which was not designed to model a real system. SIMUDELT is a significant modification of DELTASIM which includes the effects of tides and longshore transport and is intended to investigate and predict the growth of real deltas. The depth of fresh water is modeled as a sine wave with amplitude of one half the tidal range and period of one tidal cycle. The cycle is partitioned and the discharge evaluated at the midpoint of each subinterval; the sum is taken over one tidal cycle and used as the unit of sediment discharge. The longshore transport is described by a Gaussian distribution with mean of one half the distance from the shoreline to the breaker line. The fraction of the deposited sediment to be transported is calculated from the ordinate of the normal curve; appropriate shifts of sediment are made at the end of each interval of deposition. The functions used to describe the tides and the longshore transport were assumed as examples for modeling. Other functions

more descriptive of a given situation could be substituted and treated by the same methods. References (5 items).

Sherk, J.A., Jr., O'Connor, J.M., and Neumann, D.A. Effects of Suspended Solids on Selected Estuarine Plankton. U.S. Army Coastal Engineering Research Center, Miscellaneous Report No.76-1, January 1976. (See annotation in Section II.)

Sherk, J.A., O'Connor,J.M., Neumann, D.A., et al. Effects of Suspended and Deposited Sediments on Estuarine Organisms - Phase II. University of Maryland, C.B.L. Ref. No.74-20, March 1974. NTIS Report AD A011 372. (See annotation in Section II.)

Shindala, A., Zitta, V.L., and Corey, M.W. Water Quality Models for the Pascagoula River Basin; II: Tidal Estuaries. Engineering and Industrial Research Station, Mississippi State University, May 1973.

A two-dimensional, vertically well mixed, steady-state, intertidal model was developed to describe the distribution of conservative and non-conservative substances within the estuarine system of the Pascagoula River Basin. The model was applied to define the concentrations of chloride, carbonaceous BOD, nitrogen and dissolved oxygen. The complex geometry of the system coupled with the desire to develop a model that best describes the phenomenon which takes place in a natural water system and still provides maximum flexibility and minimum input requirements necessitated the selection of the two-dimensional model. Field data from two independent surveys were used to verify the model. The Surveillance and Analysis Division, U.S. Envrionmental Protection Agency, Region IV, collected field data, mainly on the Escatawpa Estuary, during the months of July and August 1972. In addition another extensive survey was conducted by the Jackson Office, U.S. Geological Survey, Water Resources Division during the months of August and September 1972. The model was applied to assess present water quality conditions and project the effect of future municipal and industrial loads on the oxygen balance within the estuarine system. Wastewater loadings that meet the water quality criteria for dissolved oxygen of the receiving streams were assigned. References (5 items).

Sibert, J., and Parker, R.R. Effect of Pulpmill Effluent on Dissolved Oxygen in a Stratified Estuary--II. Numerical Model. WATER RESEARCH, vol.7, No.4, p.515-523, April 1973. (See annotation in Section IV.)

Silvio, G.D. Calibration of a Mathematical Model for the Stratified Salt Intrusion in Tidal River Mouths. Proceedings, XVIth Congress of the International Association for Hydraulic Research, São Paulo, Brazil, July 27 to August 1, 1975, vol.3, Paper C33. (See annotation in Section III.)

Simmons, H.B., and Herrmann, F.A., Jr. Effects of Proposed Second Entrance on the Flushing Characteristics of San Diego Bay, California. Food and Agriculture Organization of the United Nations, Technical Conference on Marine Pollution and Its Effects on Living Resources and Fishing, Rome, Italy, 9-18 December 1970. FIR: MP/70/E-103, 14 November 1970.

Since the extent to which a second entrance would increase the flushing rate of San Diego Bay would constitute a major consideration in evaluating the overall benefits of a second entrance, and since these effects could not be computed reliably by available analytical methods, it was deicided to construct a suitable physical hydraulic model of the bay in which the several suggested locations for a second entrance could be tested and the effects of each location on hydraulic and flushing characteristics of the bay could be investigated in detail. The model was constructed to linear scale ratios, model to prototype, of 1:500 horizontally and 1:100 vertically.

Smith, B.N. The Role of Sea Grasses and Benthic Algae in the Geochemistry of Trace Metals in Texas Esturies. Texas University, Department of Botany, October 1974. (See annotation in Section II.)

Smith, R. Coriolis, Curvature and Buoyancy Effects upon Dispersion in a Narrow Channel. Hydrodynamics of Estuaries and Fjords; Proceedings of the 9th Liege Colloqium on Ocean Hydrodynamics, 1977, p.217-232. (See annotation in Section IV.)

Spalding, D.B. Heat and Mass Transfer in Rivers, Bays, Lakes and Estuaries. Imperial College of Science & Technology, London, Mechanical Engineering Department, Heat Transfer Section, HTS/76/7, April 1976.

The physical processes and mathematical problems associated with the title subject are reviewed. It is asserted that, although means exist for solving even the most complex three-dimensional and time-dependent problems, their expense is currently too great for practical use. Consequently, the need for simplified models is great. The bulk of the article concerns simplified models of a special type: those which are described mathematically by two-dimensional parabolic differential equations to be solved numerically. Attention is concentrated on jets, plumes and layers of warm water. References (59 items).

Spaulding, M. Numerical Modeling of Pollutant Transport Using a Lagrangian Marker Partical Technique. National Aeronautics and Space Administration, Technical Memorandum NASA TMX-73930, August 1976.

A derivation and code have been developed for the three-dimensional mass transport equation, using a particle-in-cell solution technique, to solve coastal zone waste discharge problems where particles are a major component of the waste. Improvements in the particle movement techniques have been suggested and typical examples illustrated. Preliminary model comparisons with analytic solutions for an instantaneous point release in a uniform flow have shown good results in resolving the waste motion. The findings to date indicate that this computational model will provide a useful technique to study the motion of sediment, dredged spoils, and other particulate waste commonly depositied in coastal waters. References (14 items).

Spaulding, M.L. Two-Dimensional, Laterally-Integrated Estuarine Numerical Water Quality Model. Ph.D. Dissertation, University of Rhode Island, 1972.

In many estuaries such as Narragansett Bay, vertical variations of water quality parameters are considerably larger than the cross-sectional differences. With this consideration in view the mass-transport equation for a constituent was laterally integrated thus effectively reducing the equation to two-spatial dimensions and one temporal dimension. Employing an alternating-direction-implicit (A.D.I.), finite-difference approximation to the original parabolic, partial differential mass-transport equation, with a standard Peaceman-Rachford splitting technique on a space-staggered grid system, computer models for both a dimensional and a dimensionless vertical axis model were constructed. Using an approach developed by Leendertse, the stability, dissipative and dispersive effects of the finite-difference approximations were studied to determine their characteristics and computer models were run for conservative constituent cases to check mass conservation over the entire grid field. These runs showed typical conservation of mass, with typical tidal velocity fields, to be within ±0.2% over several days simulation time. In order to further verify model performance the B.O.D. - D.O. reaction scheme was programmed and trial runs made on the non-dimensional vertical axis model to determine the effects of changes in reaeration and B.O.D. decay coefficients as well as no load and over-load for B.O.D. point sources. Model runs verified that the effects of changes in each of these parameters had the desired qualitative effect on the levels of the water quality parameters. Further model verification was made by simulating normal summer-time conditions for Narragansett Bay's D.O. - B.O.D. profiles and comparing them to actual data. Results indicate that the values are good to excellent for D.O. data and fair to good for the B.O.D. data, both concerning tidal cycle variation and vertical structure. Presentation of predictive model results is shown by typical B.O.D. storm-sewerage overflow for a one day period leading to an estimated Bay "cleanup time" of approximately 2.5 days. Bibiography (37 items).

Specialty Conference on Dredging and Its Environmental Effects; Proceedings; Mobile, Alabama, January 26-28, 1976. Edited by Peter A. Krenkel, John Harrison and J. Clement Burdick III. New York, American Society of Civil Engineers, 1976. (See annotation in Section V.)

Steele, J.G., Pearce, B.R., Wang, J.D., et al. Finite-Element Modeling of Moreton Bay, Australia. Ralph M. Parsons Laboratory for Water Resources and Hydrodynamics, Department of Civil Engineering, Massachusetts Institute of Technology, Technical Note No.20, July 1977.

Finite-element modeling was applied to Moreton Bay, a tidal estuary on the east coast of Australia. The CAFE and DISPER computer programs were employed. The results, which have not been verified by field data, are in general agreement with what is known of the circulation in the bay; they are reported here, both as a guide to future modeling, and as an incentive to future field measurements. Typical results are presented to show the tidal circulation as well as circulation due to a river flood. Results are also presented for the dispersion of suspended

solids at various locations in the bay, under tidal or river flood conditions. The effect of winds is examined. References (o items).

Stigebrandt, A. On the Effect of Barotropic Current Fluctuations on the Two-Layer Transport Capacity of a Constriction. JOURNAL OF PHYSICAL OCEANOGRAPHY, vol.7, No.1, p.118-122, January 1977. (See annotation in Section I.)

Stone, J.H. Louisiana Superport Studies, Report No.2: Preliminary Assessment of the Environmental Impact of a Superport on the Southeastern Coastal Area of Louisiana. Louisiana State University, Department of Marine Sciences, Center for Wetland Resources, No.LSU SG 72 05, Report 2, 1972. (See annotation in Section VII.)

Sullivan, R.H. The Effect of Tidal Currents on Planned Effluent Discharge in Puget Sound. Ocean 75 Record: 1975 IEEE Conference on Engineering in the Ocean Environment, and Eleventh Annual Meeting of the Marine Technology Society, San Diego, California, September 22-25, 1975, p.940-943. (See annotation in Section IV.)

Sumer, S.M., and Fischer, H.B. Transverse Mixing in Partially Stratified Flow. Journal of the Hydraulics Division, Proc. ASCE, vol.103, No.HY6, p.587-600, June 1977.

The paper reports the results of a laboratory study on the rate of transverse mixing in oscillatory estuary-type flow with density gradients typical of those found in real estuaries. Two sets of experiments were performed: one in a uniform channel with a trapezoidal cross section, and one in a channel with an irregular cross section. In the uniform channel density stratification reduced the rate of transverse mixing. A plot of the dimensionless transverse mixing coefficient versus Richardson Number is given. In the irregular channel, the density stratification had an opposite effect: the irregular side wall generated vertical mixing which induced transverse density gradients and transverse flows. It is concluded that real estuaries are probably similar to the irregular channel and that density stratification in real estuaries may hasten rather than impede transverse mixing. References (9 items).

Sündermann, J. A Three Dimensional Model of a Homogeneous Estuary. Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, Copenhagen, Denmark, vol.III, 1975, Chapter 136 (p.2337-2356).

Based on HANSEN's hydrodynamical-numerical method, a three dimensional model of wind and tidally generated processes in a homogeneous estuary is developed. The model includes an arbitrary depth distribution and the simulation of a boundary layer near the bottom. Some numerical examples demonstrate the applicability for practical purposes. References (6 items).

Sündermann, J., Wulzinger, W., and Vollmers, H. The Effect of Dam Constriction on Tidal Processes in an Estuary. Proceedings, XVIth Congress of the International Association for Hydraulic Research, São Paulo, Brazil, July 27 to August 1, 1975, vol.1, Paper A12.

The effect of a gradual damming up of a tidal estuary is investigated. The specific changes of tidal elevation, velocity fields and circulation systems are studied simultaneously by a numerical and a physical model. Special attention is directed to the modeling of the turbulent separation zone behind the obstacle. The results of both model types are compared. References (5 items).

Symposium on Direct Tracer Measurement of the Reaeration Capacity of Streams and Estuaries, July 7-8, 1970, Proceedings . . . Georgia Institute of Technology, Atlanta; Ernest C. Tsiviglou, Mark A. McClanahan, and Walter M. Sanders III. Environmental Protection Agency, Water Pollution Control Research Report, Project 16050 FOR, January 1972. (See annotation in Section VII.)

Taylor, C., and Davis, J.M. A Finite Element Model of Tides in Estuaries. Paper presented at the International Symposium on Finite Element Methods in Flow Problems, held in January 1974 in Swansea, United Kingdom. In: Finite Element Methods in Flow Problems, edited by J.T. Oden, O.C. Zienkiewicz, R.H. Gallagher, and C. Taylor, The University of Alabama in Huntsville, 1974, p.371-377.

The non-linear equations governing tidal propagation in estuaries are solved using the Finite Element Method (F.E.M.). The method of weighted residuals, in

particular the Galerkin method, is used in association with the finite element discretisation technique to formulate the necessary matrix equations. These recurrent equations are solved in a stepwise, in time, manner. Although the resulting solution algorithm can be applied to effect solutions to such problems as seiche and long wave motion in harbors and rivers, the current presentation is limited to tidal propagation in estuaries and seas. References (7 items).

Taylor, C., and Davis, J.M. A Numerical Model of Dispersion in Estuaries. Paper presented at the International Symposium on Finite Element Methods in Flow Problems, edited by J.T. Oden, O.C. Zienkiewicz, R.H. Gallagher, and C. Taylor, The University of Alabama in Huntsville, 1974, p.379-384.

The formidable task of simulating the dispersion of effluents within a tidal domain has been the objective of numerous researches utilizing both physical and numerical models. Since the 'real' system under consideration is highly complex in topology, flow and effluent species, any simulation will always be subject to limitations. However, if the engineering and biological significance of such limitations are appreciated a rationalization of the model findings can be utilized effectively. The relevant model predictions can then be used to assist in the management of rivers, estuaries and seas. A numerical computer based model would have the distinct advantage, over their physical counterparts, that any change in the state of the domain can be readily analyzed with a minimum of effort. The only stipulation is that a suitable computer based model is already available (from paper). References (8 items).

Taylor, C., and Davis, J. Tidal and Long Wave Propagation -- A Finite Element Approach. COMPUTERS AND FLUIDS, vol.3, No.2/3, p.125-148, June 1975.

The governing equations of tidal flow are solved for a two-dimensional domain using the finite element method. The appropriate vertically integrated differential equations are replaced by an equivalent set of integral equations which result in a coupled matrix relationship. Three time stepping schemes are investigated. These are the Adams-Moulton multi-step predictor corrector process, the trapezoidal finite difference integration scheme, and the finite element in time. The algorithm is used to predict long wave forms, in rectangular channels, arising from tidal variations and constant wind forces. The tidal propagation in the southern North Sea is also presented. References (23 items).

Tee, K.T. Tide-Induced Residual Current, a 2-D Nonlinear Numerical Tidal Model. JOURNAL OF MARINE RESEARCH, vol.34, No.4, p.603-628, November 1976.

Tide-induced residual current was studied through solution of the two-dimensional nonlinear shallow-water equation. A simple numerical method was developed and applied to Minas Channel and Minas Basin at the head of the Bay of Fundy where strong residual currents of up to 0.76 m/sec have been measured. Two models are considered: the first is rectangular, of constant depth, and has a shape similar to the Minas Channel and Minas Basin, and the second approximates the actual geometry of the area studied. The numerical solutions are stable under various conditions and produce four strong eddies in the residual current. The results obtained with the models are strongly supported by the observations available. A test indicates that the residual currents are induced by the tidal current through the inertial effect. In terms of vorticity, the residual eddies result from the advection of vorticity generated in a boundary layer. References (25 items).

Teubner, M.D., and Noye, B.J. Numerical Simulation of Tidal and Thermal Propagation in a Shallow Channel. Fifth Australasian Conference on Hydraulics and Fluid Mechanics, University of Canterbury, Christchurch, New Zealand, 9-13 December 1974; Conference Proceedings, vol.II, p.294-301.

The non-linear equations of motion, continuity and heat exchange for a one-dimensional tidal wave propagating along a shallow channel closed at one end are solved using an explicit finite-difference scheme. The results of the numerical computations for a one-dimensional model to determine the temperature distribution in a long tidal inlet, resulting from the discharge of heated water at the closed end of the channel, are given. This represents a first approximation to the situation in Angas Inlet, South Australia, caused by the hot water discharge from the Torrens Island Power Station. References (3 items).

Texas Water Development Board. Techniques for Evaluating the Effects of Water Resources Development on Estuarine Environments. Texas Department of Water Resources, LP-75, 1978.

The research project was designed to provide a set of analytical techniques for use by water resources planners and decision-makers to assist in measuring and evaluating the effects of water resources development on estuarine environments. The techniques are designed to be sufficiently flexible to analyze many types of water development and management policies. The report describes: (1) the techniques developed by the Texas Water Development Board to measure the environmental impact of water resources development on estuarine environments, and (2) the application of these techniques to a prototype Texas River basin - estuarine system to demonstrate the methodolgy. At this time, results are not definitive but serve as a valuable learning tool. Environmental effects of water development and management are examined by simulation models of stream, reservoir, and estuarine environments, and placed within a flexible analytical framework for evaluating a wide range of alternatives. An estuarine ecological model (ESTECO) and an estuarine model (MOM) for migratory organisms (Gulf shrimp) were developed for use with existing Board models that were designed to simulate stream, reservoir, and river basin conditions as water use demands increase on projected scales. The test case was executed on the Guadalupe Estuary and its major contributing drainages, the San Antonio and Guadalupe River Basins. Year 2000 simulations indicate water use projections would increase frequency of low flow events with varying environmental effects. Bibliography (35 items).

Thacker, W.C. Irregular Grid Finite-Difference Techniques: Simulations of Oscillations in Shallow Circular Basins. JOURNAL OF PHYSICAL OCEANOGRAPHY, vol.7, No.2, p.284-292, March 1977.

Finite-difference techniques for irregular computational grids are presented. Successful simulations of transient normal mode oscillations in shallow circular basins, where analytic solutions are known, demonstrate that these techniques can yield accurate results, even in situations involving a curved boundary. These techniques should prove to be quite useful for numerically forecasting storm surges in bays and estuaries where calculations are complicated by the curving coastline. References (15 items).

Thatcher, M.L., and Harleman, D.R.F. Development and Application of a Deterministic Time-Varying Salinity Intrusion Model for the Delaware Estuary (MIT-TSIM). Prepared for the Delaware River Basin Commission, November 1978. 2 vol. (See annotation in Section III.)

Thatcher, M.L., Pearson, H.W., and Mayor-Mora, R.E. Application of a Dynamic Network Model to Hydraulic and Water Quality Studies of the St. Lawrence River. Symposium on Modeling Techniques, 2nd Annual Symposium of the Waterways, Harbors and Coastal Engineering Division of ASCE, San Francisco, California, September 3-5, 1975, vol.II, p.1196-1219.

A network-type numerical model of hydraulics and water quality has been implemented to provide predictive capability in the study of the St. Lawrence River from Cornwall, Ontario, past Montreal and downstream into the tidal region as far as Montmagny, Quebec. The M.I.T. Dynamic Network Model was adopted for this study. It consists of a coupled solution to the governing equations of transient hydraulics and mass transport for a network of one-dimensional reaches of variable cross-sectional area. Modifications were made to the original model to adapt it for ice cover, to provide for continuity across control structures, and to include additional water quality parameters including an interactive nutrient model. Verification was made to steady-state conditions in the nontidal region and to transient conditions in the tidal region. The model represents a management tool for predicting the results of different hydraulic and water quality conditions. These conditions can be natural ones such as floods, icing, storm tides and storm water runoff, or they can be related to human activity such as dam regulation, changes in river geometry, degrees of waste water treatment and the location of outfalls. References (9 items).

Thomann, R.V., Di Toro, D.M., and O'Connor, D.J. Preliminary Model of Potomac Estuary Phytoplankton. Journal of the Environmental Engineering Division, Proc. ASCE, vol.100, No.EE3, p.699-715, June 1974.

The upper 40-mile reach of the Potomac Estuary is modeled by a nonlinear, time variable representation of phytoplankton dynamics. Nitrogen and phosphorus recycling is included. Sensitivity analyses indicate that phytoplankton from tidal embayments can contribute as much as 40 µg/l to observed chlorophyll in the main channel. Loss of phosphorus to the sediments is significant. Flow transport through the estuary and the nutrients and phytoplankton associated with increasing river flow are particularly important.

Simulations indicate that under non-drought flows and a 90% reduction of untreated nutrient loads, chlorophyll concentrations in the main channel may rise to 50 µg/l and to 70 µg/l in tidal embayments. These concentrations are above an objective of 25 µg/l, but are about 60% less than present values. References (8 items).

Thornton, E.B., and Romer, L.S. Comparison of Hydraulic and Numerical Tidal Models. Symposium on Modeling Techniques, 2nd Annual Symposium of the Waterways, Harbors and Coastal Engineering Division of ASCE, San Francisco, California, vol.II, September 3-5, 1975, p.1311-1328.

A comparison is made of the merits and limitations of hydraulic and numerical models. The discussion is limited to models having uniform density over depth and the driving force is the tide only. The model comparison is for San Diego Bay. Prototype measurements were used to calibrate both models. Comparable results are obtained from the hydraulic and numerical models dependent on how well they are calibrated. Techniques are described to divide large arrays representing embayments in the numerical model into smaller segments that are handled more easily and faster in the computer. This technique can allow using finer mesh lengths to obtain better spatial resolution. References (10 items).

Timmerman, H. Meteorological Effects on Tidal Heights in the North Sea. Royal Netherlands Meteorological Institute, KNMI-102-99, 1977. (See annotation in Section I).

Tomczak, M., and Diaz, C.G. A Numerical Model of the Circulation in Cienfuegos Bay, Cuba. ESTUARINE AND COASTAL MARINE SCIENCE, vol.3, No.4, p.391-412, October 1975.

The circulation in a very shallow (<30m), nearly enclosed bay of estuarine characteristics is calculated, integrating the hydrodynamic equations numerically and including frictional and diffusive terms. In order to reproduce the observed shallow pycnocline and the surface density distribution the coefficient of virtual diffusion has to be inversely proportional to the square of the density gradient. Transitory internal periodic motion is damped out by applying relatively strong bottom friction. The resulting density distribution compares well with observations. The circulation is computed for two basically different situations: during the dry season, the main part of the bay is governed by wind-driven westward surface flow, eastward subsurface slow and corresponding coastal sinking and upwelling regions; the vertically integrated net flow is counter-clockwise. The smaller southern part, which is separated from the main part by a sill of less than 1.5 m depth, is governed by a similar circulation involving, however, exchange with the Caribbean Sea and clockwise net flow. River runoff governs the circulation during the wet season. In the northern part of the bay the surface layer of outgoing fresh water is very shallow (2 m or less) but deepens as the outlet into the Carribbean Sea is approached. The southern part of the bay shows only a very little motion. The area around the industrial town of Cienfuegos is nearly stagnant throughout the year, especially during the wet season. References (18 items).

Townson, J.M. An Application of the Method of Characteristics to Tidal Calculations in (x-y-t) Space. JOURNAL OF HYDRAULIC RESEARCH, vol.12, No.4, p.499-523, 1974. (See annotation in Section I.)

Tronson, K.C.S., and Noye, B.J. Propagation of Tides into the South Australian Gulf System. Fifth Australasian Conference on Hydraulics and Fluid Mechanics, University of Canterbury, Christchurch, New Zealand, 9-13 December 1974; Conference Proceedings, vol.II, p.258-267.

Tidal propagation into the South Australian gulfs, viz. Spencers Gulf and Gulf St. Vincent, has been modeled using numerical analogs of the linearized forms of the vertically integrated hydrodynamical equations of motion and continuity. Co-range and co-tidal lines for K_1 and M_2 tidal components produced by this model fill some gaps on the co-range and co-tidal charts produced in 1970, by Easton, from coastal recordings. The system enables the amplitude and phase of tide components to be determined for locations near shore where harbors are being planned and off shore where drilling rigs may be located. Using these components the tide regime can be established for assessment by coastal engineers. Meteorological effects on water levels in the gulfs have also been computed using this model. References (12 items).

Tsai, Y.H., and Holley, E.R. Temporal Moments for Longitudinal Dispersion. Journal of the Hydraulics Division, ASCE, vol.104, No.HY12, p.1617-1634, December 1978. (See annotation in Section IV.)

U.S. Army Corps of Engineers, Committee on Tidal Hydraulics. Unsteady Salinity Intrusion in Estuaries; Part I: One-Dimensional, Transient Salinity Intrusion with Varying Freshwater Inflow; Part II: Two-Dimensional Analysis of Time-Averaged Salinity and Velocity Profiles, by D.R.F. Harleman, J.S. Fisher, and M.L. Thatcher. Technical Bulletin No.20, July 1974. (See annotation in Section III.)

U.S. Army Engineer Waterways Experiment Station. Effects of 40-ft Charleston Harbor Project on Tides, Currents, and Salinities; Hydraulic Model Investigation, by H.A. Benson. Miscellaneous Paper H-76-9, May 1976.

The purpose of the model study was to determine the effects of deepening the existing -35 ft Charleston Harbor project to -40 ft on tidal heights, current velocities, and salinities for two average weekly Pinopolis release conditions: the present 15,600-cfs flow and a 3,500-cfs rediversion flow. For this study, the Navy navigation channel, located from mile 20.6 to mile 23, remained at -35 ft. The channel seaward from about Ft. Sumter was deepened an additional 2 ft to -42 ft for the plan tests. No changes in alignments or widths of the existing navigation channel were considered. The plan tests were conducted with the Wando River deepened from the mouth to mile 2.5 to -35 ft. This was a proposed deepening in the Wando River for the Wando Terminal under consideration at the time the plan tests were conducted. The model was constructed to linear scale ratios, model to prototype, of 1:2000 horizontally and 1:100 vertically. These scale ratios fixed the following model-to-prototype relations: slope, 20:1; velocity, 1:10; time, 1:200; discharge, 1:2,000,000; and volume, 1:400,000,000. The salinity scale ratio was 1:1, and the model ocean supply was maintained at a salinity of 30,000 parts per million total salts. One prototype tidal cycle of 12 hr 25 min was reproduced in the model in 3.725 min. The model was approximately 137 ft long, 46 ft wide at the widest point, and covered an area of about 3600 sq ft. It was constructed within a shelter to protect it from the weather and to permit uninterrupted operation.

U.S. Army Engineer Waterways Experiment Station. Grays Harbor Estuary, Washington; Report 5, Maintenance Studies of 35-Ft-Deep (MSL) Navigation Channel; Hydraulic Model Investigation, by N.J. Brogden, Jr. Technical Report H-72-2, Report 5, October 1975.

The existing, comprehensive fixed-bed model of the Grays Harbor estuary was used to determine the effectiveness of three proposed dredged material areas in the estuary entrance in retaining material deposited from a hopper dredge; the effects of three proposed Sand Island Shoal Channel realignment plans (including one plan with a confined disposal area) on channel shoaling, current velocities, and salinities; the effects of eight proposed confined dredged material disposal islands on channel shoaling; and the effects of six channel improvement plans (training dike, groin fields, and turning/settling basin) on channel shoaling, surrent velocities, surface directions, salinities, and dye dispersion. Prior to conducting channel shoaling tests, a comprehensive shoaling verification of the navigation channel was completed. During the shoaling verification, model operation procedures were developed by trial and error to achieve satisfactory reproduction of observed prototype shoaling distribution patterns within various reaches of the navigation channel.

U.S. Army Engineer Waterways Experiment Station. Grays Harbor Estuary, Washington; Report 6, 45-Ft MSL (40-Ft MLLW) Navigation Channel Improvement Studies; Hydraulic Model Investigation, by N.J. Brogden, Jr. Technical Report H-72-2, Report 6, April 1976.

The existing, comprehensive fixed-bed model of the Grays Harbor estuary was used to determine the effects of enlarging (deepening and widening) the existing 35-ft-deep channel to a depth of 45 ft msl. One 45-ft improvement plan consisting of 23 groins and a relocated turning/settling basin was also investigated. Model tests were conducted on the above plans to determine effects on tidal heights, current velocities and patterns, salinity intrusion, dye dispersion, and channel shoaling. The scope of data collected while testing the improvement plan was not as extensive as for the enlarged channel itself; however, the data obtained were considered sufficient to define the effects resulting from the plan.

U.S. Army Engineer Waterways Experiment Station. Heat Dispersion in Physical Estuarine Models; Report 1, State of the Art, by V.L. Zitta and G.W. Douglas. Research Report H-75-2, Report 1, June 1975.

Prototype heat exchange mechanisms and scaling laws for the reproduction of

thermal phenomena in hydraulic models are presented for each stage of the dispersion process. These stages are: (a) turbulent or momentum entrainment at the efflux jet, (b) buoyant rise or fall of the heated plume, (c) convective spread of the plume over the surface of the receiving waters, (d) mass transport of the plume by ambient currents, (e) diffusion and dispersion due to turbulence in the receiving waters, and (f) surface heat exchange with the atmosphere. As with any modeling effort, it is impossible to adequately model all phenomena simultaneously with only one model. The area near the efflux jet where turbulent entrainment and buoyancy are the significant dispersion mechanisms is referred to as the "near field." In this area the densimetric Froude number is the scaling criteria for modeling entrainment and the path of the plume. The modeling of turbulent entrainment and buoyancy requires an undistorted-scale model to ensure similitude of turbulent diffusion. The area where convective spread, surface heat exchange, mass transport by ambient currents, and ambient turbulent diffusion are the important dispersion processes is referred to as the "far field." The scaling criterion for convective spread is the densimetric Froude number. The standard Froude number is the scaling criterion for the ambient currents where vertical distortion is usually required to ensure that Reynolds numbers are large enough to ensure fully turbulent flow in the model. If the main dispersion stages in the far field are ambient turbulence and convective spread turbulence, an undistorted-scale model is required since there is no known way of distorting turbulence. Similarity of surface heat exchange coefficients may require a distorted-scale model, but this distortion is to a limited degree compatible with the distortion required to ensure fully turbulent flow. Bibliography (15 items).

U.S. Army Engineer Waterways Experiment Station. Heat Dispersion in Physical Estuarine Models; Report 2, Experiments in the Delaware River Model, by M.J. Trawle. Research Report H-75-2, Report 2, February 1976.

This report is the second of three to be published on the results of investigations of heat dispersion in physical estuarine models conducted in the Delaware River and Trinity Bay models for the Office, Chief of Engineers, U.S. Army. The first report, "Heat Dispersion in Physical Estuarine Models; Report 1, State of the Art," discussed the theoretical aspects of physcial heat dispersion modeling in general, while the third report will concern experiments in the Trinity Bay model. The results of this investigation indicate that the Delaware River physical model at the U.S. Army Engineer Waterways Experiment Station can be used effectively to predict the thermal plume characteristics from certain types of heated discharges into the Delaware Estuary. Specifically, the discharges investigated on the Delaware River are classified as low densimetric Froude number discharges, i.e., canals or low-exit-velocity pipe discharges. The near-field distortion effect is at a minimum in the model with this type of discharge. No comparative tests of high densimetric Froude number discharges (diffusers) have been conducted in the model; therefore, it cannot be concluded from this investigation that the Delaware River model can adequately predict thermal plume characteristics for the latter-type discharge into the Delaware Estuary, nor are the results of this study readily transferable to other estuary models, especially those of dissimilar estuaries or those of different scales.

U.S. Army Engineer Waterways Experiment Station. Improvements for Masonboro Inlet, North Carolina; Hydraulic Model Investigation, by W.C. Seabergh. Technical Report H-76-4, April 1976. 2 vols.

The Masonboro Inlet fixed-bed model was constructed of concrete to scales of 1:300 horizontally and 1:60 vertically. The model reproduced an area extending to the -45 ft contour in the Atlantic Ocean and to the extent of the influence of the inlet in the bay. The wetlands were accurately reproduced near the inlet, but those relatively flat areas farther bayward were reproduced schematically and artificially bent into the research flume to provide storage for the tidal prism. Model verification tests assured that the model hydraulic and shoaling regimes were in satisfactory agreement with the prototype. Preliminary testing included the examination of tidal surface current patterns for various structural configurations, including training structures to deflect currents away from the north jetty, offshore breakwaters, and various south jetty alignments. Plan B of the Wilmington District, CE, was selected as the best design and was subjected to detailed testing. This testing indicated that construction of the plan B south jetty would aid in maintaining a channel more centrally located between the jetties, away from the north jetty. The construction of a deposition basin in Banks Channel near the entrance of the inlet was also investigated. It was found that the basin produced velocity increases along the Wrightsville Beach

shoulder of the inlet. References (4 items).

U.S. Army Engineer Waterways Experiment Station. Interim Report on Masonboro Inlet, North Carolina, Movable-Bed Model Tests, by N.W. Hollyfield. Miscellaneous Paper H-76-14, June 1976.

The purpose of this study was to evaluate the reliability of movable-bed hydraulic model predictions of inlet response to a major coastal engineering construction project when verification is based on pre-construction conditions. Implicit in the purpose of this project was the need to model a prototype inlet affording both good pre-construction data for model adjustment and verification and good post construction data for comparison of results. It was originally ascertained that Masonboro Inlet, North Carolina, met the data requirements better than any other inlet. It was hoped that model results would provide some insight to a solution for shoaling and channel migration problems that had occurred subsequent to construction of the authorized navigation channel in 1959. References (3 items).

U.S. Engineer Army Waterways Experiment Station. Masonboro Inlet, North Carolina: Movable-Bed Hydraulic Model Study, Effects of Temperature and Experimental Procedures, by R.A. Sager and N.W. Hollyfield. Miscellaneous Paper H-75-10, December 1975.

The study was conducted to determine the effects of water temperature on the results from a movable-bed model study of Masonboro Inlet, North Carolina, with a secondary objective to determine the effects of experimental procedures on the model results. The erratic reproduction of short-period waves near the beach and inlet was found to be the most probable source of experimental error. Other experimental errors discussed include the influence of initial molding of the movable bed, method of simulation of littoral transport approaching the inlet test sections, and bed sounding procedure. The study did not define temperature effects on movable-bed model results; however, no evidence was found to indicate that temperature adversely affected the results of the Masonboro Inlet model tests within the range of temperatures investigated (50 to 78°F). A general course of action to resolve the question of temperature effects is recommended. The study consisted of three pairs of tests. Two pairs of tests were conducted with different water temperatures; the third pair was conducted with the same water temperature and was thus a "control" series. Results of the hydrographic surveys are presented in Appendix A; scour and fill maps are presented in Appendix B; and beach profiles for each test are presented in Appendix C. References (11 items).

U.S. Army Engineer Waterways Experiment Station. Mathematical Model of Estuarial Sediment Transport, by R. Ariathurai, R.C. MacArthur, and R.B. Krone. Technical Report D-77-12, October 1977.

A two-dimensional finite element model that stimulates erosion, transport, and deposition of suspended sediments is presented. The breadth-averaged or depth-averaged equations may be used depending on the problem to be solved. The governing equations for two phase transport are derived and then solved by the finite element method using isoparametric quadrilateral elements in which a quadratic approximation is made for the suspended sediment concentrations. Expressions used for the rates and conditions under which erosion and deposition occur are from previous experimental studies. Continuing aggregation is accounted for by specifying the settling velocity of the flocs in each element at each time step. The bed is considered to be formed of a number of layers of sediment whose physical properties change with overburden pressure. The model provides suspended sediment concentrations and bed profile at each time step. Numerical stability and convergence tests were conducted by comparing simulated results with analytic solutions and actual measurements. The original model, SEDIMENT I, was verified by comparison with measurements in a recirculating flume. The modified model, SEDIMENT II, developed for this project was verified by comparison with field measurements in the Savannah Estuary, Georgia. References (31 items).

U.S. Army Engineer Waterways Experiment Station. Model Studies of Navigation Improvements, Columbia River Estuary; Report 2: Entrance Studies; Section 4: Jetty A Rehabilitation, Jetty B, and Outer Bar Channel Relocation, by F.A. Herrmann, Jr. Technical Report No 2-735, Report 2, Section 4, July 1974.

The existing, comprehensive fixed-bed model of the Columbia River estuary was used to determine the effects of jetty A rehabilitation, construction of jetty B, and relocation of the outer bar channel on entrance area conditions. Model tests were conducted to determine the hydraulic, salinity, and shoaling characteristics of the entrance area. Test results

consist of tidal measurements, current velocity measurements, salinity measurements, photographs of surface and bottom current patterns, and shoaling patterns. The results of the model tests indicate that (a) rehabilitation of jetty A would have no significant effect on entrance channel shoaling; (b) construction of jetty B would reduce the shoaling rate by about 28 percent and alter the shoaling distribution pattern in the inner bar channel; and (c) relocation of the outer bar channel would not significantly reduce requirements for maintenance dredging, except for a possible short-term reduction of undetermined amount and duration.

U.S. Army Engineer Waterways Experiment Station. Navigation Channel Improvements, Barnegat Inlet, New Jersey; Hydraulic Model Investigation, by R.A. Sager and N.W. Hollyfield. Technical Report H-74-1, March 1974.

The model study of Barnegat Inlet was conducted to evaluate the effectiveness of proposed plans of improvements to stabilize the size and location of the authorized navigation channel through the inlet. Tests were conducted in a fixed-bed model to define the effects of each stage of a multistage plan of improvement on the hydraulic characteristics of the inlet. The model was then converted to a movable-bed model, and the effects of the multi-stage plan of improvement on the movement of material were defined. The results of the tests indicated that the key to the improvement of navigation conditions in the inlet is a new south jetty to be constructed essentially parallel to the existing north jetty. Tests were then conducted to evaluate the length and height of the twin jetties. Based on the results of the study, it is recommended that the following sequence of improvements be employed: Remove existing south jetty, working landward from the ocean end and leaving a short section of the jetty for beach stabilization. At the same time, construct the new south jetty (use stone from old jetty in new jetty if it is economical). Prior to closure of the south channel by construction of the jetty, begin dredging a navigation channel of 300-ft width and 8-ft depth at mean low water on a line from deep water in the throat to a point midway between the ocean end of the existing jetties. Raise the north jetty to +8 ft mlw from the beach to a point 1200 ft from the ocean end of the jetty. Dredge a 300-ft-wide interior channel to a depth of 10 ft mlw on a line favoring deep water at the throat of the inlet bayward to deep water at the north end of the existing sand dike. Consider in sequence the groin field (stage 2) and sand dike (stage 4) should the interior channel subsequently prove to require excessive maintenance.

U.S. Army Engineer Waterways Experiment Station. Numerical Analysis of Tidal Circulation for Long Beach Harbor, by D.C. Raney. Miscellaneous Paper H-76-4, Report 1, September 1976; Report 2, March 1976; Report 3, September 1976; Report 4, May 1976.

Report 1: Existing Conditions and Alternate Plans for Pier J Completion and Tanker Terminal Study. Report 2: Tidal Circulation Velocity Patterns for Existing Conditions and Alternate Master Plan Pier-J Configurations for Sohio Project. Report 3: Existing Conditions and Alternate Plans for Pier J Completion and Tanker Terminal Study with -82 ft Channel. Report 4: Tidal Circulation Velocity Patterns for Existing Conditions and Alternate Master Plan Pier-J Configurations with -82 ft Channel. The study was conducted for Long Beach Harbor to numerically investigate tidal circulation in existing basins and to define and evaluate the impact of possible modification of Pier J on existing harbor circulation. A two-dimensional depth-averaged formulation of the hydrodynamic equations was used in the model and an implicit-explicit finite difference scheme was used to numerically solve the equations. The numerical model was verified using tide and velocity data from the prototype and from physical model tests conducted at WES. For each Pier J modification considered, overall tidal circulation patterns were obtained hourly by vector plots of the tidal velocity at each finite difference cell. The change in overall tidal circulation patterns from those presently existing were also determined. The mass flow rates through the breakwater openings and channels were calculated and compared with those flows currently existing in the harbor. Changes in flow rates as a result of the Pier J modifications were identified.

U.S. Army Engineer Waterways Experiment Station. Physical Hydraulic Models. Assessment of Predictive Capabilities, Report 1, Hydrodynamics of the Delaware River Estuary Model, by J.V. Letter, Jr., and W.H. McAnally, Jr. Research Report H-75-3, Report 1, June 1975.

The purpose of the study is to define the reliability with which results of tests conducted in a physical model of the Delaware River Estuary can be used to predict the effects of modifications to the estuary. The Delaware River model at the Waterways Experiment Station was used

to conduct tests to predict the effects of the navigation channel enlargement between Philadelphia and Trenton, and the results of the tests are compared with subsequent prototype data to determine the accuracy of the model predictions. It is concluded that, for projects involving estuarine modifications up to the scale of navigation channel enlargement, the physical hydraulic model, when carefully verified, can accurately predict the effects of the project on the estuarine system. Undue emphasis should not be placed upon absolute values at specific locations since discrepancies may occur due to scale effects or the dynamic nature of prototype conditions. References (5 items).

U.S. Army Engineer Waterways Experiment Station. Tillamook Bay Model Study; Hydraulic Model Investigation, by G.M. Fisackerly. Technical Report H-74-11, November 1974.

The Tillamook Bay model was of the fixed-bed type, constructed to scales of 1:500 horizontally and 1:100 vertically, and reproduced Tillamook Bay, Oregon, in its entirety and a suitable area of the Pacific Ocean. The model was equipped with the necessary appurtenances for accurate reproduction and measurement of tides, tidal currents, salinity intrusion, freshwater inflow, shoaling distribution, and other significant prototype phenomena. The purpose of the model study was to determine the optimum alignment and length of south jetty at the entrance to Tillamook Bay. Model verification tests indicated that the model hydraulic and salinity regimens were in satisfactory agreement with those of the prototype for comparable conditions. It therefore can be assumed that the model provided quantitative answers concerning the effect of the proposed plans on the hydraulic and salinity regimens of the bay. The optimum plan consisted of existing conditions plus a 7000-ft south jetty located 1200 ft from the north jetty. Lengths greater than this do not modify the shoaling pattern to any great degree and should be considered only if additional protection for navigation is required.

U.S. Army Engineer Waterways Experiment Station. Westport Small-Boat Basin Revision Study; Hydraulic Model Investigation, by N.J. Brodgon, Jr. Miscellaneous Paper H-75-8, November 1975.

An existing comprehensive fixed-bed model of the Grays Harbor Estuary was used to evaluate the flushing characteristics of three proposed revision plans to the existing Westport Small-Boat Basin. Model tests were conducted to determine current velocities in the two exits for base conditions and plan 1, surface current patterns for base conditions and plans 1 and 3, and flushing characteristics for base conditions and plans 1-3. Each plan improved flushing with plan 3 being the most effective.

U.S. Geological Survey. Digital Flow Model of the Chowan River Estuary, North Carolina, by C.C. Daniel. Water Resources Investigations 77-63, August 1977.

A one-dimensional deterministic flow model based on the continuity equation has been developed to provide estimates of daily flow past a number of points on the Chowan River estuary of northeast North Carolina. The digital model, programmed in Fortran IV, computes daily average discharge for nine sites; four of these represent inflow at the mouths of major tributaries, the five other sites are at stage stations along the estuary. Because flows within the Chowan River and the lower reaches of its tributaries are tidally affected, flows occur in both upstream and downstream directions. The period of record generated by the model extends from April 1, 1974, to March 31, 1976. During the two years of model operation the average discharge at Edenhouse near the mouth of the estuary was 5,830 cu ft per sec. Daily average flows during this period ranged from 55,900 cu ft per sec in the downstream direction on July 17, 1975, to 14,200 cu ft per sec in the upstream direction on November 30, 1974. Selected references (25 items).

U.S. Geological Survey. A Numerical Model of Material Transport in Salt-Wedge Estuaries. Geological Survey Professional Paper 917, 1975.

Part I. Description of the Model, by H.B. Fischer. Water in a salt-wedge estuary ideally is characterized by an oscillating well-mixed wedge of undiluted seawater topped by a series of successively more dilute overlying layers. In the wedge the flow is back and forth, with a net landward component to replace water entrained upward into the overlying layer; in the overlying layers the flow also oscillates, but with a net seaward component because of the input of fresh river water and entrained wedge water. The flow is modeled by a computer program, and the flow is used as an input to the constituent-transport model. The computer program then is used to determine the advection and dispersion of dissolved constituents and plankton, and

their concentrations throughout the system in response to given inputs. The report describes required input data and method of operation of the computer program. References Cited (10 items).
Part II. Model Computation of Salinity and Salt-Wedge Dissolved Oxygen in the Duwamish River Estuary, King County, Washington, by J.D. Stoner, W.L. Haushild, and J.B. McConnell. Saltwater from Elliott Bay on Puget Sound forms a wedge in the lower part of the Duwamish River estuary. The numerical model described by Fischer in Part I of this report was used in computing salinity distributions in the estuary, and oxygen-use rates and dissolved-oxygen distributions in the salt wedge. Computed spatial distributions of salinity agreed well with observed distributions during about 30 slack tides in July and August 1968. Analyses of the sensitivity of computed salinity to changes in model input parameters indicate that salinity changed most in repsonse to changes in the wedge salinity and the location of the wedge toe. The rate of use and the concentration of dissolved oxygen (DO) in the salt wedge were computed by the model for June-August 1968 and for the June-September periods of 1967 and 1969-71. Before 1970, the estuary received discharges of treated, partly treated, and raw industrial and municipal wastes; after 1970, the only major source of waste was the effluent from the Renton Treatment Plant, a secondary treatment plant. Attributable to these changes in waste disposal to the estuary were (1) observed wedge DO concentrations generally 2 mg/l greater in 1970-71 than in 1967-69, and (2) oxygen-use rates in the wedge 60 percent greater during 1967-69 than during 1970-71. Analyses of covariance indicate that computed wedge DO concentrations were not different (95 percent confidence level)* from observed concentrations, and the standard error of estimate of the computed concentrations ranged from 10 percent (1971) to 22 percent (1967) of the observed mean concentrations. Sensitivity analyses indicate that wedge DO concentration changed proportionally with oxygen-use rate and also was sensitive to changes in the wedge tow location and in the velocity of the water entrained from the wedge. The model was used to predict the changes that would have occurred in the oxygen-use rate and DO concentrations in the wedge during June-September 1971 if discharge of Renton Treatment Plant effluent had been increased from a 1971 average of 37 ft^3/s (63 m^3/min) to the planned maximum of 223 ft^3/s (379 m^3/min). The predictions suggest that (1) oxygen-use rate would have been increased by 92 percent, (2) a relatively low DO concentration (4 mg/l) would have been decreased by 45 percent, and (3) a relatively high concentration (9 mg/l) would have been decreased by 8 percent. References Cited (12 items).

Van de Kreeke, J. Increasing the Mean Current in Coastal Channels. Journal of the Waterways, Harbors and Coastal Engineering Division, Proc. ASCE, vol.102, No.WW2, p.223-234, May 1976. (See annotation in Section I.)

Vicens, G.J., Harley, B.M., and Schaake, J.C., Jr. FLOW2D: A Two-Dimensional Flow Model for Flood Plains and Estuaries. Symposium on Modeling Techniques, 2nd Annual Symposium of the Waterways, Harbors and Coastal Engineering Division of ASCE, San Francisco, California, September 3-5, 1975, vol.II, p.1487-1504.

The simulation of flows and/or stages in wide and irregular flood plains and estuaries frequently requires a two-dimensional representation of the flow processes be used. In such cases a one-dimensional model may significantly underestimate the stages or flows in certain portions of the area being modeled while overestimating those in other portions. This paper presents the theory, a solution procedure, and a practical application of a two-dimensional model, FLOW2D, which has been used in a number of practical, engineering problems. References (4 items).

Vincent, C.E., and Smith, D.J. Measurements of Waves in Southampton Water and Their Variation with the Velocity of the Tidal Current. ESTUARINE AND COASTAL MARINE SCIENCE, vol.4, No.6, p.641-652, November 1976. (See annotation in Section I.)

Vreugdenhil, C.B., and Voogt, J. Hydrodynamic Transport Phenomena in Estuaries and Coastal Waters: Scope of Mathematical Models. Symposium on Modeling Techniques, 2nd Annual Symposium of the Waterways, Harbors and Coastal Engineering Division of ASCE, San Francisco, California, September 3-5, 1975, vol.I, p.690-708. Same: Delft Hydraulics Laboratory, Publication No.155, December 1975.

An analysis is given of the assumptions in different types of mathematical models for the transport of water and other quantities in estuaries and coastal waters. The starting-point is formed by the equations for three-dimensional turbulent flow. An estimate of the importance of various terms is given. By

several averaging processes, increasingly simpler models are obtained, but the interpretation of coefficients becomes increasingly more difficult. Also the numerical possibilities are discussed, with special emphasis on aspects of accuracy and non-linear stability which are considered the most important numerical problems. Throughout the paper, attention is limited to nearly horizontal flow, although the influence of short waves on these flows is also treated. In the discussion the parallel between momentum and mass transfer (hydrodynamics and water quality) is taken into account. References (26 items).

Wada, A., and Miyaike, Y. Study on Adaptability of Prediction Method of Simulation Analysis for Diffusion of Discharged Warm Water in the Bay. Civil Engineering Laboratory, Central Research Institute of Electric Power Industry. Technical Report C: 374004, November 1975.

Adaptability of the prediction method of the simulation analysis for the diffusion of the discharged warm water in the bay is discussed comparing the predictive computation results with the actual measurement results regarding the region of the discharged warm cooling water diffusion from a group of thermal power stations located in the innermost of the Ise Bay which was selected as the investigated site. The numerical simulation analysis itself was conducted on the basis of the oceanographical observations at the investigated sea region. In the innermost of the Ise Bay there exists the Nagoya Coastal Industrial Zone where Chita, Nishinagoya, Shinnagoya, and Meiko thermal power stations are located. The total capacity of these facilities comes up to approximately 4,000 MW. The cooling water of these power stations is all discharged into the harbor of Nagoya. The innermost of the Ise Bay is partitioned by the breakwater against the high tide, and inside the breakwater the Nagoya Harbor is situated. The sea water exchange is done through the two mouths of the breakwater. References (1 item).

Wallis, I.G. Lagrangian Box Models of Waste Transport in Tidal Waters. Australia Institution of Engineers, Civil Engineering Transactions, vol.CE 19, No.1, p.101-109, 1977. (See annotation in Section IV.)

Walsh, P.J., and Noye, B.J. A Numerical Model of Wind-Induced Circulation in the Murray Mouth Lakes, South Australia. Fifth Australasian Conference on Hydraulics and Fluid Mechanics, University of Canterbury, Christchurch, New Zealand, 9-13 December 1974; Conference Proceedings, vol.II, p.284-293.

Varying wind stress is the main cause of water level variations and circulation in the system of Murray Mouth lakes, South Australia. Strong winds can cause low-lying areas at their leeward shore to be flooded and irrigation inlet pipes to be exposed at their windward shore. Knowledge of the circulation is important for the prediction of dispersion of pollutants within the lakes. These effects are modeled numerically by a scheme which can incorporate the channel connecting the lakes. Results are presented for a wind regime of constant strength which rotates anticlockwise diurnally and persists for up to a week at a time, this being a typical wind regime for the region. References (12 items).

Wang, J.D. Real-Time Flow in Unstratified Shallow Water. Journal of the Waterway, Port, Coastal and Ocean Division, Proc. ASCE, vol.104, No.WW1, p.53-68, February 1978.

A finite element model for prediction of time-dependent flow in shallow coastal areas is presented herein. The model is based upon the vertically integrated equations of motion combined with the hydrostatic assumption and is applicable to water bodies without vertical stratification. The time integration scheme evolves on a grid with variables staggered in time and is conditionally stable. Consistent treatment of boundaries is facilitated by the flexible grid layout, and the finite element method allows straightforward treatment of convective terms throughout the domain. All variables are defined at the same points in space. The model is applied to predict tidal flow and the flow induced by a hypothetical cooling water circulation system. References (16 items).

Wang, Y.-H. The Interfacial Stress in a Strongly Stratified Estuary. Proceedings, XVIth Congress of the International Association for Hydraulic Research, São Paulo, Brazil, July 27 to August 1, 1975, vol.1, Paper A14. (See annotation in Section III.)

Wang, Y.-H. Transverse Circulation and Mass Transport in Estuaries. University of Florida, Gainesville, Coastal and Oceanographic Engineering Laboratory, UFL/COEL/ TR-034, October 1976.

A stably stratified slow field with longitudinal and transverse circulation has

been created in a newly designed and constructed circular plexiglass basin. Two cases are being investigated, water and brine streams are introduced to the circular basin from (1) the same direction, (2) the opposite direction. In each of the two cases, the product $c'u'$ and $c'\omega'$ are measured at eight stations in the circular basin. Comparison between these longitudinal and tranxverse components are made. It is found $c'u' > c'\omega'$ at all measured stations. This result is not in agreement with Fischer's (1972) theory. It is also found that two mechanisms totally different in character are responsible for the mass transport processes in estuaries, namely instantaneous fine scale turbulent velocity fluctuations such as u', v', and ω' and large scale motions yet to be identified. These large scale motions are suspected to be in the forms of eddies and jets of various sizes. The occurrence of these large scale motions is considered to be related to the sudden expansion of river and tidal flows in the estuary and the estuarial boundaries. References (34 items).

Wang, J.D., and Connor, J.J. Finite Element Model of Two Layer Coastal Circulation. Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, Copenhagen, Denmark, vol.III, 1975, Chapter 141 (p.2401-2420).

A set of "averaged" partial differential equations for the circulation in a two layered coastal water is established by assuming each layer to be vertically homogeneous and by performing a vertical integration over the layer thicknesses. Since the phenomena to be investigated typically consist of long waves such as a tidal wave, the hydrostatic pressure assumption is also introduced. The finite element method is employed to transform the partial differential equations to a discrete system of ordinary differential equations which are solved using an implicit time stepping method similar to the trapezoidal rule, but with the variables (elevation and flows) staggered in time. A linear stability analysis shows the initial value problem to be unconditionally stable. In practice, instability due to boundary conditions and non-linearity sets in. Comparisons between computed and analytical solutions for simple cases give good agreement. The tidal excitation of Massachusetts Bay, represented as a rectangular basin with opening on one side, is presented as an illustrative example. References (13 items).

Wang, J.D., and Connor, J.J. Mathematical Modeling of Near Coastal Circulation. Ralph M. Parsons Laboratory for Water Resources and Hydrodynamics, Report No.200, April 1975.

Hydrodynamic circulation in coastal waters is formulated in terms of mathematical models. A systematic discussion of the derivation of a set of governing equations, expressing conservation of mass and momentum is presented. A simplification is introduced by integrating all variables and equations over the total water depth. The derivation of the vertically integrated formulation for one and two layered situations is discussed along with the underlying assumptions and closure problems. The treatment of boundaries and boundary conditions is given particular attention. By analogy to the mechanics of a particle it is postulated that the admissible boundary conditions must either be in terms of forces or discharges. References (81 items).

Wang, S., and Hwang, L.-S. Numerical Simulation of Oil Slick Transport in Bays. Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, Copenhagen, Denmark, vol.III, 1975, Chapter 129 (p.2227-2244).

A computer model for simulating oil spreading and transport has been developed. The model can be utilized as a useful tool in providing advance information and thus may guide decisions for an effective response in control and clean-up once an accidental spill occurs. The spreading motion is simulated according to the physical properties of oil and its characteristics at the air-oil-water interfaces. The transport movement is handled by superimposing the spreading with a drift motion caused by winds and tidal currents. By considering an oil slick as a summation of many elementary patches and applying the principle of superposition, the model is capable of predicting the oil size, shape, and movement as a function of time after a spill originates. Field experiments using either cardboard markers or soybean oil to simulate a spill were conducted at the Long Beach Harbor. Computer predictions showed good agreement with the field traces. References (11 items).

Wang, S.T., McMillan, A.F., and Chen, B.H. Analytical Model of Dispersion in Tidal Fjords. Journal of the Hydraulics Division, Proc. ASCE, vol.103, No.HY7, p.737-751, July 1977.

Using the integral transforms technique, the unsteady three-dimensional advective-diffusion equation was solved analytically for the dispersion of pollutants from an instantaneous point source in open channels of finite width. The flow velocity through the channel was the mean current velocity which was assumed to vary sinusoidally with time but linearly with water depth. The effect of first-order reactions is to reduce the concentration level throughout the channel. The spread of pollutants in the direction of mean flow is accelerated as a result of the existence of a vertical shear. The width of the channel is important, as is the boundary in the y direction that profoundly affects the horizontal dispersion when the source is close to the bank, but its effect diminishes as the source is moving farther away from the bank. These findings, as well as others, are examined and illustrated graphically. References (19 items).

Wang, Y.-H., et al. Satellite Applications to a Coastal Inlet Study, Clearwater Beach, Florida. University of Florida, Gainesville, Coastal and Oceanographic Engineering Laboratory, UFL/COEL-77/026, December 1977. (See annotation in Section VII.)

Ward, G.H. Formulation and Closure of a Model of Tidal-Mean Circulation in a Stratified Estuary. Estuarine Processes; Volume II, Circulation, Sediments, and Transfer of Material in the Estuary, edited by Martin Wiley. New York, Academic Press, 1977, p.365-378.

We consider the formulation of the lateral-mean tidal-mean momentum and salt balances in an estuary with rectilinear cross-section. Explicit treatment of the density current, typical of tidal-mean estuarine circulation, requires solution of the coupled equations of momentum and salinity. Central to this is the specification of the vertical eddy fluxes. Analysis of data from the Mersey and James estuaries indicates that the entirety of the vertical structure of the salt flux is determined by the local gravitational stability and the proximity to the vertical boundaries of the system, the absolute magnitude of the flux being established by the bulk hydrodynamic characteristics of the estuary. The structure of the momentum flux is further dependent upon the Richardson number ratio Rf/Ri, for which a functional form is suggested. An idealized analytical solution is given and numerical solution of the more general equations is discussed. References (23 items).

Ward, P.R.B. The Transver e Distribution of Velocity in Estuary Flow. JOURNAL OF HYDRAULIC RESEARCH, vol.12, No.2, p.253-274, 1974. (See annotation in Section I.)

Weare, T.J. The Economic Disadvantages of the Finite Element Method for Two-Dimensional Tidal Hydraulics. HRS Notes (Hydraulics Research Station, Great Britain), No.18, p.5-6, May 1976.

In the past year or so considerable effort has been devoted to the problem of applying the method of finite elements to the solution of the two-dimensional shallow water equations. Hitherto little attention has been paid to the question of the relative economics of the finite element method compared with the widely used method of finite differences. Paper presents general considerations which suggest that for the type of practical problems which arise in the modeling of the tidal hydraulics of estuaries, seas and coastal waters, the finite element method is not economically viable. References (5 items).

Weare, T.J. Instability in Tidal Flow Computational Schemes. Journal of the Hydraulics Division, Proc. ASCE, vol.102, No.HY5, p.569-580, May 1976. Discussion, No. HY12, p.1787-1790, December 1976.

A careful analysis of the multioperational finite difference schemes proposed by Leendertse reveals a nonlinear numerical instability. This instability arises from the imperfect time centering of certain nonlinear terms in the shallow water equations. For many applications, the natural damping due to the friction term controls or masks the instability. The results of the stability analysis suggest that the instability becomes uncontrollable when a small grid spacing is used. These conclusions are confirmed by numerical experiment. References (3 items).

Weel, M.A. van. Le Canal du Rhin a l'Escaut. Amenagements de l'Estuaire de l'Escaut. (The Rhine-Scheldt Canal. Improvement Works in the Scheldt Estuary). Bulletin of the Permanent International Association of Navigation Congresses, No.17, p.37-41, 1974. (In French, English summary.) (See annotation in Section V).

Weisberg, R.H. The Nontidal Flow in the Providence River of Narragansett Bay: A Stochastic Approach to Estuarine

Circulation. JOURNAL OF PHYSICAL OCEANOGRAPHY, vol.6, No.5, p.721-734, September 1976.

Atmospherically driven flow in the Providence River (a partially mixed estuary) has been examined using a 51-day velocity record measured 2 m from the bottom. Velocity fluctuations at time scales between the steady-state gravitational convection and the tidal oscillations were large and almost exclusively wind-induced. The mean and variance of the velocity component lying along the channel axis were 11.7 cm s^{-1} (landward) and 166.9 cm^2 s^{-2}. Of this axial current variance 48% resided at subtidal frequencies as compared to 45% associated with semidiurnal tides (the remaining 7% was mostly due to higher tidal harmonics). Over the most energetic portion of the axial current spectrum (periodicities of 4-5 days), 97% of the variance was coherent with the wind velocity component lying along the direction of maximum fetch, with the current lagging the wind by about 4 h. Owing to this extremely high coherence, a linear time-invariant stochastic model reproduced the axial current from the two orthogonal wind velocity components to within an rms error of 2.3 cm s^{-1}. The wind also had a marked effect upon the density field. It is concluded that the effects of wind can permeate the entire water column of a partially mixed estuary and can be of equal (or greater) importance to the circulation as the tides or gravitational convection. References (24 items).

Welander, P. Two-Layer Exchange in an Estuary Basin, with Special Reference to the Baltic Sea. JOURNAL OF PHYSICAL OCEANOGRAPHY, vol.4, No.4, p.542-556, October 1974. (See annotation in Section I.)

Whalin, R.W. Hydraulic Model Evaluation of Coastal Evolution Due to Offshore Structures. SHORE AND REACH, vol.43, No.1, p.9-20, April 1975.

The author emphasizes that the fixed-bed hydraulic model, either undistorted or distorted, is a valuable tool available to the coastal engineer for attempting to determine the potential effect of offshore structures on coastal evolution. Model measurements of longshore currents, breaking wave heights, breaking depth, and angle can be used to evaluate the relative effect of the proposed construction on coastal evolution. A distorted fixed-bed hydraulic model was used as this concept was applied to the evaluation of the effect of the Atlantic Generating Station on coastal evolution near Little Egg Inlet, New Jersey. References (7 items).

Whipple, W., Jr., Hunter, J.V., Ahlert, R.C., et al. Estimating Runoff Pollution from Large Urban Areas--The Delaware Estuary. New Brunswick, NJ, Rutgers University, Water Resources Research Institute, July 1978. (See annotation in Section IV.)

Whipple, W., Jr., Hunter, J.V., Dittman, F.W., et al. Oxygen Regeneration of Polluted Rivers: The Passaic River. Water Resources Research Institute, Rutgers University, New Brunswick, NJ, Water Pollution Control Research Series, 16080 FYA 03/71. (See annotation in Section IV.)

White, P.M., Lessmann, R.C., and Spaulding, M.L. Numerical Estuarine Models for Water Quality Management in the Blackstone River-Providence River and the Taunton River-Mt. Hope Bay Complexes. Rhode Island Water Resources Center, Completion Report, OWRR Project A-059-RI, June 30, 1976.

A one-dimensional numerical finite-difference model is developed for computing water quality parameters in a river basin. The model is then applied to the Blackstone River Basin between Auburn, Massachusetts, and Central Falls, Rhode Island. The river is divided into 57 numerical segments of average length 4900 ft and average cross-section 500 sq ft. Source loads are given for the various constituent discharges into the river. Computations are made for the distribution of dissolved oxygen, biochemical oxygen demand, total phosphates, ammonia nitrogen, nitrate nitrogen, total alkalinity, and total coliforms, for four different seasonal river volume flow rates. Literature Cited (7 items).

White, S.M., Jirka, G.H., and Harleman, D.R.F. Experimental Investigation of Submerged Condenser Cooling Water Discharge into Casco Bay (William F. Wyman Station). Ralph M. Parsons Laboratory for Water Resources and Hydrodynamics, Department of Civil Engineering, Massachusetts Institute of Technology, Report No.186, July 1974.

A tidal model, at an undistorted scale of 1/100, was constructed and operated to study the near-field temperature effects on Casco Bay, Maine, of the proposed Units #3 and #4 submerged cooling water discharge from the W.F. Wyman Electric

Generating Station. The Station is located on Cousins Island and will have a capacity of 824 MW_e. Three discharge modes were tested: single pipe, double pipe and multiport diffuser designs. The discharge will be subject to State of Maine and Federal thermal standards. With regard to these standards, the experimental results indicate that the discharge area in Casco Bay, off Cousins Island, is generally well-suited for a submerged condenser water discharge. This is due to the combination of two factors: relatively deep water with sufficient tidal advective motion and relatively small condenser heat input. Single pipe and double pipe discharges typically produce higher temperature maximums, while multiport diffusers spread the discharge flow over a certain distance and thus reduce the maximum temperature rises. In particular, it was found that a 480 ft long multiport diffuser with unidirectional nozzle orientation is most satisfactory for the heated discharge, as induced near-field temperature rises are minimized and the diffuser length is relatively short. References (3 items).

Williams, B.J., and Hinwood, J.B. On the Development and Calibration of a Large Numerical Hydrodynamic Model. Fifth Australasian Conference on Hydraulics and Fluid Mechanics, University of Canterbury, Christchurch, New Zealand, 9-13 December 1974; Conference Proceedings, vol.II, p.244-249.

Aspects of the development and calibration of a large two-dimensional hydrodynamic model are described. This numerical model is one of a sequence of models used to simulate water movement and water quality changes in bays and estuaries currently being applied to Westernport Bay near Melbourne. The development of the model included adapting it to the available computer and modifying it to treat a bay with tidal mud flats. The criteria for selection of model time step and spatial grid size are then discussed. Model calibration is defined and each of the adjustments which may be made to bring model and field measurements into accord are described. It is concluded that adaptation of one of the available hydrodynamic models to a particular computer and a given bay takes time and involves detailed consideration of both the physical and computational factors. References (4 items).

Williams, J.M. Scaling Criteria for Hydraulic Modelling of Thermal Plumes. HRS Notes (Hydraulics Research Station, Great Britain), No.18, p.6-8, May 1976.

Scaling of hot-water plumes in conventional hydraulic models is recognized as unreliable since the criteria governing the scaling of the overall model do not apply to the phenomena contributing to the development of the plume. In a recent study at the Hydraulics Research Station, concerning Littlebrook Power Station on the River Thames, an attempt was made to generate a representative plume in steady unidirectional flow in a flume.

Wilson, J.F., Lowrey, D.P., and Millan, J.D. Dredging with Tidal-Powered Jets. Eighth Annual Offshore Technology Conference, Houston, Texas, May 3-6, 1976; Proceedings, vol.III, Paper No.OTC 2585.

One alternative for maintaining channels at a specified depth is to locally accelerate the tidal currents with a transportable, bottom-crawling funnel whose jet aids in scouring. Toward this end, several 1/30th scale model configurations were built and tested in a laboratory flume to study the effects on volume yield rate (jet-scoured trench size) of the controlling system parameters. Correlated data lead to an optimum dredge-jet design: a 1/4th scale configuration for field tests at the Duke University Marine Laboratory harbor channel, Beaufort, N.C. If future field tests are as successful as the laboratory experiments presented here, full-scale tidal-powered dredging jets with yield rates exceeding 0.6 m^3/min may be realized. References (3 items).

Winter, D.F. Studies of Circulation and Primary Production in Deep Inlet Environments. U.S. Environmental Protection Agency, EPA-600/3-77-049, April 1977. (See annotation in Section I.)

Wolanski, E.J., and Banner, M.L. Buoyant Surface Jets in Tidal Longshore Currents. Journal of the Hydraulics Division, Proceedings, ASCE, vol.104, No.HY11, p.1505-1519, November 1978.

Calculations are presented showing that a three-dimensional buoyant surface jet discharged supercritically into an infinitely large and quiescent body of receiving water transitions to subcritical flow without the occurrence of an internal hydraulic jump. A numerical model is also used to predict the bulk behavior of the jet created by the discharge of a buoyant effluent into a reversing longshore current. It is found that the plume is stretched in the offshore direction and that the bulk Richardson number

attains a local maximum along the plume center line. It is concluded that the presence of the reversing current will not generally inhibit dilution of the plume. However, under certain circumstances, the model predicts a second transition from subcritical back to supercritical flow; laboratory observations suggest that this corresponds to a splitting of the plume into two parts, one actively growing and the other floating passively in the current and later reentrained into the growing plume. References (21 items).

Wollast, R. Modelling of Biological and Chemical Processes in the Scheldt Estuary. Hydrodynamics of Estuaries and Fjords; Proceedings of the 9th Liege Colloquium on Ocean Hydrodynamics, 1977, p.63-77.

The chemical and biological processes occurring in natural environments are known to be very complicated according to the intricated interactions of numerous factors. In the case of the estuarine systems, the mixing of fresh water and sea water induces furthermore large changes of ionic strength, chemical composition, speciation and distribution of organisms along the estuary, which renders the situation even more complicated than in most more homogeneous environments. These processes are thus described generally by rather approximate semi-empirical relations as shown for example in this paper by the behaviour of dissolved silica and nitrate in the Scheldt estuary. These approximations do not justify in many cases the use of elaborated hydrodynamical models and to our opinion a stationary one dimensional model constitutes a sufficient first approach. Management decisions are often required urgently in order to prevent the increasing pollution of many estuaries. In this respect, the use of these simple models constitutes a useful tool realising a compromise among viability, cost and time requirements. References (13 items).

Wood, E.F., Harley, B.M., and Perkins, F.E. Transient Flow Routing in Channel Networks. WATER RESOURCES RESEARCH, vol.11, No.3, p.423-430, June 1975.

The formulation of a mathematical model to predict transient flows in hydraulic networks is presented. The network formulation consists of breaking the network up into a series of connected reaches; reducing the finite difference equations for each reach into two "reach" equations; forming an exterior matrix consisting of the reach equations, external boundary conditions, and interior compatibility conditions; solving the external matrix for the end values of discharge and water surface elevation for all reaches; and back-substituting for all interior values. Examples presented include the James River, USA, estuary model (24 nodes and 26 reaches), the Cork Harbor, Ireland, estuary (13-reach double-looped network), and the Rio Bayamon basin, Puerto Rico. Results are very satisfactory when they are compared to known data. References (6 items).

Yalin, M.S., and Price, W.A. Time Growth of Tidal Dunes in a Physical Model. Symposium on Modeling Techniques, 2nd Annual Symposium of the Waterways, Harbors and Coastal Engineering Division of ASCE, San Francisco, California, September 3-5, 1975, vol.II, p.936-944.

A method is suggested to determine the scale of the duration of the development of dunes forming on the bed of a tranquil flow. It is expected that the scale relations determined should be applicable to both unidirectional and tidal flows. The derivation rests on dimensional principles as well as on a mathematical relation describing the duration of development as a certain function of the geometric dimensions of dunes in their developed state, and a typical transport rate. The treatment is two-dimensional, the granular material being cohesionless. It is assumed that the movable bed of the model is formed by either sand or a lightweight material. The application of the method is illustrated by a numerical example. References (6 items).

Zvirin, Y., and Shinnar, R. A Comparison of Lumped-Parameter and Diffusional Models Describing the Effects of the Outlet Boundary Conditions on the Mixing in Flow Systems. WATER RESEARCH, vol.10, No.9, p.765-779, 1976.

A comparison is presented between 2 methods of modeling the disperison and mixing processes in large turbulent flow systems such as estuaries, coastal waters, and atmospheric systems. One method is based on the diffusional model and the other is a lumped-parameter model, referred to as "box-mode" or compartmental model. The models are compared on the basis of model free parameters defined as the purging rate and remaining life distribution. There exists a good agreement between the results of both models for a 1-dimensional system. The boundary condition problem at the outlet is discussed with the conclusion that the use of a mass transfer coefficient may be justified where inflows can be estimated. When these inflows are strong a sink at the outlet can be taken as a boundary condition. References (21 items).

SECTION VII. SURVEYS AND INSTRUMENTS

Methods and techniques of field surveys, observations, sampling, measurements, and data collection, and various types of instruments, gages, and sampling devices.

Abood, K.A. Circulation in the Hudson Estuary. Hudson River Colloquium. Annals of the New York Academy of Sciences, vol.250, p.39-111, May 24, 1974. (See annotation in Section I.)

Aeration of the Thames. COMPRESSED AIR MAGAZINE, May 1972, p.12. (See annotation in Section IV.)

Alexander, V., Burrell, D.C., Chang, J., et al. Environmental Studies of an Arctic Estuarine System - Final Report. Institute of Marine Science, University of Alaska, Fairbanks, EPA-660/3-75-026, June 1975. (See annotation in Section VIII.)

Allen, G.P. Relationship Between Grain Size Parameter Distribution and Current Patterns in the Gironde Estuary (France). JOURNAL OF SEDIMENTARY PETROLOGY, vol.41, No.1, p.74-88, March 1971. (See annotation in Section II.)

Allen, G.P., Bonnefille, R., Courtois, G., et al. Processus de sédimentation des vases dans l'estuaire de la Gironde. Contribution d'un traceur radioactif pour l'étude du déplacement des vases (Sediment Drift and Accumulation Processes in the Gironde Estuary. Contribution of a Radioactive Tracer to the Study of Mud Displacement). LA HOUILLE BLANCHE, vol.29, No.1/2, p.129-136, 1974. (In French.) (See annotation in Section II.)

Allen, G.P., Sauzay, G., Castaing, P., et al. Transport and Deposition of Suspended Sediment in the Gironde Estuary, France. Estuarine Processes; Volume II, Circulation, Sediments, and Transfer of Material in the Estuary, edited by Martin Wiley. New York, Academic Press, 1977, p.63-81. (See annotation in Section II.)

Amos, C.L., and Collins, M.B. The Combined Effects of Wave Motion and Tidal Currents on the Morphology of Intertidal Ripple Marks: The Wash, U.K. JOURNAL OF SEDIMENTARY PETROLOGY, vol.48, No.3, p.849-856, September 1978. (See annotation in Section II.)

Anderson, F.E. The Effect of Boat Waves on the Sedimentary Processes of a New England Tidal Flat. University of New Hampshire, Department of Earth Sciences and Jackson Estuarine Laboratory, Durham, Technical Report, 1 February 1974. (See annotation in Section II.)

Anderson, R.R. Remote Sensing of Marshlands and Estuaries Using Color Infrared Photography. Earth Resources Aircraft Program Status Review, Volume III - Hydrology, Oceanography, and Sensor Studies, Section 26; Presented at the NASA Manned Spacecraft Center, Houston, Texas, September 16 to 18, 1968.

Preliminary report discusses the capability of low-altitude color infrared photos for evaluating marshland vegetation and water quality in estuaries. Various filters were used with color infrared film to determine the optimum filter for the best photos of the estuarine environment. Several color infrared photos of the Patuxent River in Maryland are shown. Information on water salinity, turbidity, currents, pollution, marshland vegetation, and submerged vegetation can be obtained from color infrared photos. A tabular summary of identifiable imagery on color infrared photos of marshlands and estuaries is included. References (6 items).

Anderson, R.R. The Use of Color Photography in Marshland and Estuarine Studies. In New Horizons in Color Aerial Photography; A Seminar sponsored by the American Society of Photogrammetry and The Society of Photgraphic Scientists and Engineers, June 9-11, 1969, p.281-288.

Color and color infrared aerial photography are compared to determine usefulness in estuarine and marshland research. Conclusions are that color infrared photography is superior in determining turbidity patterns and sources of nutrient pollution. It is equal to color photography in delimiting plant species which are good indicators of water salinity. At higher altitudes color infrared may be superior in this respect also due to haze penetration. Suggestions are given for further research. Literature Cited (6 items).

Anwar, H.O. Turbulent Dispersion and Meandering of a Surface Plume. Proceedings, XVIth Congress of the International Association for Hydraulic Research, São Paulo, Brazil, July 27 to August 1, 1975, vol.1, Paper A46. (See annotation in Section I.)

Arthur, J.F. Preliminary Studies on the Entrainment of Suspended Materials in Suisun Bay, San Francisco Bay-Delta Estuary. Proceedings of a Workshop on Algae Nutrient Relationships in the San Francisco Bay and Delta, held November 8-10, 1973, at Clear Lake, California, p.17-36. The San Francisco Bay and

Estuarine Association, 1975. (See annotation in Section VIII.)

Barwis, J.H. Annotated Bibliography on the Geologic, Hydraulic, and Engineering Aspects of Tidal Inlets. U.S. Army Corps of Engineers, General Investigation of Tidal Inlets, GITI Report 4, January 1976. (See annotation in Section III.)

Bastin, A. Natural Radioactive Tracers and Their Use in Belgium: Lithological Maps of the Bottom of the North Sea Off the Belgian Coast and of the Scheldt Estuary Constructed on the Basis of Natural Radioactivity Measurements. Paper presented at a panel meeting on the Use of Tracers in Sedimentology, held at the Centre d'Etudes Nucleaires de Saclay, 21-25 June 1971. In: Tracer Techniques in Sediment Transport, International Atomic Energy Agency, Vienna, Technical Report Series No.145, p.179-200, May 1973.

One of the main questions arising during sedimentological investigations is how far the samples are representative; it is necessary to know how many additional samples have to be taken in order to provide an answer to this question. When, in 1961, research was begun on the sedimentology of the southern part of the North Sea and the Scheldt estuary the problem of the representativeness of the sampling also arose. The first year was devoted to traditional close sampling. The results were not very fruitful, owing to the considerable variations of the bottom. In 1962 we became acquainted with the radioactive tracer method which was being developed for the determination of sediment transport. We then observed the differences in natural radioactivity exhibited by sea-bed sediments of various compositions, and made use of this phenomenon in drawing up lithological maps on a large scale with a view to finding out the lateral representativeness of a given composition. References (7 items).

Benedict, P.C. Equipment for Investigations of Fluvial Sediment. Journal of the Hydraulics Division, ASCE, vol.105, No.HY3, p.163-170, March 1979.

The role of the Federal Inter-Agency Sedimentation Project is historic in the studies of (1) the equipment for measurement and analysis of sediment discharge; (2) the mechanics of sediment transportation; and (3) the design and development of improved equipment for the measurement and analysis of fluvial sediment discharge. The article presents the titles of the 14 reports published as a part of the project activity that cover the studies of equipment used prior to 1940 and the design and development of new equipment. Mention is made that the requirement of Environmental Impact Statements for proposed water-related project has emphasized the need for the measurement of both suspended and bedload. Information on equipment furnished to Federal agencies and photographs of major equipment now in current use together with current studies now in progress are also outlined. References (6 items).

Bennett, A.F., and Long, T. An Electro-Mechanical Tide Gauge. THE INTERNATIONAL HYDROGRAPHIC REVIEW, vol.52, No.1, p.137-142, January 1975.

Describes a prototype transducer in which gas pressure changes are converted to shaft rotations; it is temperature compensated and has a digital recorder. A range of 30 m and sensitivity to 1 mm of water is claimed. References (4 items).

Biggs, R.B., and Flemer, D.A. The Flux of Particulate Carbon in an Estuary. MARINE BIOLOGY, vol.12, No.1, p.1117, 1972. (See annotation in Section VIII.)

Billen, G. Nitrification in the Scheldt Estuary (Begium and The Netherlands). ESTUARINE AND COASTAL MARINE SCIENCE, vol.3, No.1, p.79-89, January 1975. (See annotation in Section IV.)

Bioindicators of Pollution; Volume 2. November 1799-October 1978: A Bibliography with Abstracts. Elizabeth A. Harrison, Editor. National Technical Information Service. NTIS/PS/1143, October 1978. (See annotation in Section IV.)

Blair, C.H. Similitude of Mass Transfer Processes in Distorted Froude Model of an Estuary. Ph.D. Dissertation, Old Dominion University, Norfolk, Virginia, March 1976. (See annotation in Section VI.)

Blair, C.H., Cox, J.H., and Kuo, C.Y. Investigation of Flushing Time in the Lafayette River, Norfolk, Virginia. Department of Civil Engineering, School of Engineering, Old Dominion University, Norfolk, Virginia, Technical Report 76-C4, December 1976.

Two consecutive dye tracer experiments were conducted in the Lafayette River during the period July 14 to August 29, 1976, in order to determine the flushing time of the estuary. Slug releases of

Rhodamine WT fluoescent dye in the north branch (km 8) and at the mouth of the main branch (km 1.5) produced concentration fields which were periodically monitored. Additional parameters measured during these experiments included rainfall, salinity, and tidal height. Dye mass and center of dye mass in the estuary were determined. After tracer release at km 8 in dry summer conditions maximum dye concentration dropped 50% in about one day; about 1.5 days were required to flush 50% of the dye mass out of the north branch, while 9.5 days were required to flush a similar amount out of the mouth of the Lafayette River. When release occurred at km 1.5, about four days were required for maximum concentration to drop by 50%, while 5.5 days were required to flush 50% of the dye mass from the estuary. References (16 items).

Bohlen, W.F. An Investigation of Turbidity in Estuarine Waters. The University of Connecticut, Research Project Technical Completion Report, November 6, 1974. NTIS Report PB-238 315. (See annotation in Section II.)

Bokuniewicz, H.J. Estuarine Sediment Flux Evaluated in Long Island Sound. Ph.D. Dissertation, Yale University, May 1976. (See annotation in Section II.)

Bokuniewicz, H.J., Gordon, R.B., and Pilbeam, C.C. Stress on the Bottom of an Estuary. NATURE, vol.257, p.575-577, October 16, 1975. (See annotation in Section II.)

Bonnefille, R., Lepetit, J.P., and Lespine, E. Simulation des depôts de vase dans l'estuaire de la Gironde (Simulation of Silt Deposition in the Gironde Estuary). Proceedings, XVIth Congress of the International Association for Hydraulic Research, São Paulo, Brazil, July 27 to August 1, 1975, vol.1, Paper A24. (In French.) (See annotation in Section II.)

Bonz, P.E. Fabric Boom Concept for Containment and Collection of Floating Oil. U.S. Environmental Protection Agency, Environmental Protection Technology Series, EPA-670/2-73-069, September 1973. (See annotation in Section V.)

Boothroyd, J.C., and Hubbard, D.K. Bed Form Development and Distribution Pattern, Parker and Essex Estuaries, Massachusetts. University of Massachusetts, Coastal Research Center, Miscellaneous Paper MP 1-74, February 1974. (See annotation in Section II.)

Boothroyd, J.C., and Hubbard, D.K. Genesis of Bedforms in Mesotidal Estuaries. In: Estuarine Research, Volume II: Geology and Engineering, edited by L. Eugene Cronin, Academic Press, Inc., New York, 1975, p.217-234. (See annotation in Section II.)

Bowker, D.E., and White, W.G. Evaluation of Water Samples Collected During Landsat-1 Overpasses of the Lower Chesapeake Bay Area. Proceedings of the International Conference on Environmental Sensing and Assessment, Las Vegas, Nevada, September 14-19, 1975, vol.I.

Water samples were collected on 18 days when the LANSAT-1 satellite was passing over the lower Chesapeake Bay area. A correlation between the various water parameters has been performed for the more than 300 surface samples. Six days were sufficiently cloud free that MSS digital tapes were useful for analysis. Correlation of radiance values with the water parameters revealed a low correlation for chlorophyll and good correlations with particles and sediment. The relation of total particles to sediment was linear but varied from day to day. References (11 items).

Bricker, O.P., III, and Troup, B.N. Sediment-Water Exchange in Chesapeake Bay. In: Estuarine Research, Volume I: Chemistry, Biology, and the Estuarine System, edited by L. Eugene Cronin, Academic Press, Inc., New York, 1975, p.3-27. (See annotation in Section II.)

Buller, A.T. Sediments of the Tay Estuary. II. Formation of Ephemeral Zones of High Suspended Sediment Concentrations. The Royal Society of Edinburgh, Proceedings, Section B, vol.75, Parts 1/2, p.65-89, 1975. (See annotation in Section II.)

Buller, A.T., and McManus, J. Sediments of the Tay Estuary. I. Bottom Sediments of the Upper and Upper Middle Reaches. The Royal Society of Edinburgh, Proceedings, Section B, vol.75, Parts 1/2, p.41-64, 1975. (See annotation in Section II.)

Buller, A.T., Green, C.D., and McManus, J. Dynamics and Sedimentation: The Tay in Comparison with Other Estuaries. In: Nearshore Sediment Dynamics and

Sedimentation; An Interdisciplinary Review, edited by J. Hails and A. Carr; John Wiley & Sons, London, New York, etc., 1975, Chapter Nine (p.201-249). (See annotation in Section II.)

Burton, B.W., and Duhaut, J. Progress with Air Photography from Helicopters for Hydrographic Work. INTERNATIONAL HYDROGRAPHIC REVIEW, vol.52, No.2 p.37-51, July 1975.

Helicopters have been found to have useful applications to hydrographic tasks, especially when they can be carried on board survey ships and are thus readily available. The tasks examined in detail in this paper are the measurement of tidal streams by aerial photgraphic methods, surveying of the inter-tidal zone and the measurement of depths in shallow water. The problems of moutning the camera in the helicopter are also considered. References (12 items).

Bush, P.W. Salt-Water Movement in the Lower Withlacoochee River -- Cross-Florida Barge Canal Complex. U.S. Geological Survey, Tallahassee, Florida, Water-Resources Investigations 5-72, January 1973. (See annotation in Section III.)

Byrne, R.J., Bullock, P., and Tyler D.G. Response Characteristics of a Tidal Inlet: A Case Study. In: Estuarine Research, Volume II: Geology and Engineering, edited by L. Eugene Cronin, Academic Press, Inc., New York, 1975, p.201-216. (See annotation in Section II.)

Byrne, R.J., DeAlteris, J.T., and Bullock, P.A. Channel Stability in Tidal Inlets: A Case Study. Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, Copenhagen, Denmark, vol.II, 1975, Chapter 92 (p.1585-1604). (See annotation in Section II.)

Cannon, G.A. Observations of Bottom-Water Flushing in a Fjord-Like Estuary. ESTUARINE AND COASTAL MARINE SCIENCE, vol.3, No.1, p.95-102, January 1975. (See annotation in Section I.)

Cannon, G.A., and Laird, N.P. Variability of Currents and Water Properties from Year-Long Observations in a Fjord Estuary. Hydrodynamics of Estuaries and Fjords; Proceedings of the 9th Liege Colloquium on Ocean Hydrodynamics, 1977, p.515-535. (See annotation in Section I.)

Carlton, D.T. Energy Dispersive X-Ray (EDX) Spectroscopy. Second Joint Conference on Sensing of Environmental Pollutants, Washington, D.C., December 10-12, 1973, p.49-51.

The applications for EDX in the general fields of Pollutant Monitoring and Environmental Sciences are endless, but in order to utilize any system to its fullest potential, a thorough understanding of its operation is necessary. Thus, this paper presents first a brief discussion of the basis of X-Ray Spectroscopy and the traditional WDX technique, then a discussion of the EDX technique and its advantages, concentrating on its physical chemistry and operational aspects. References (3 items).

Carruthers, J.N. A Prototype Totalising Current-Meter (Mark II); A Self-Moored Version for Near-Surface Use Especially in Foul Water Estuaries in Connection with Pollutant Dispersal Studies. Bulletin, Institut Oceanographique, Monaco, vol.70, No.1418, 1972.

A new self-moored totalizing current meter was made expressly for recording the totality of upper water movements in 8 directions over a period of a week or more for application to questions of pollutant dispersal. The instrument is entirely mechanical and works on the Ekman ball-dropping principle. The various features of the instrument are described. Observations made with the instrument have lasted for about 14 d, but the time could be doubled or trebled by using a bigger hopper. Important features of the instrument include the facts that no dirt can get into the working parts which are inclosed in a fabric bag and the instrument can not foul its own moorings as it rides over them at slack water or change of tidal stream direction. References (7 items).

Carter, H.H. The Distribution of Excess Temperature from the Morgantown Generating Station on the Potomac Estuary. Chesapeake Bay Institute, The Johns Hopkins University, Technical Report 84, Reference 73-10, October 1973. (See annotation in Section VIII.)

Carter, H.H. The Measurement of Rhodamine Tracers in Natural Systems by Fluorescence. Proceedings, Symposium, Physical Processes Responsible for Dispersal of Pollutants in the Sea, with Special Reference to the Near-Shore Zone, held in Arhus, Denmark, 4-7 July 1972, p.193-200. Copenhagen, Denmark, December 1974.

Most tracer experiments carried out in the United States in recent years for the purpose of quantitating dispersion coefficients, verification of turbulent diffusion models, etc., have utilized rhodamine as the tracer and the Turner Model 111 Fluorometer for the assay. For optimum ease and accuracy of measurement in the field, this fluorometer must be modified and operated within certain constraints. These constraints are described. The fluorescent assay is also affected by certain water quality parameters such as temperature, pH, etc. The effect of water quality on the assay of rhodamine by fluorescence is described and the effect quantitated or estimated. References (11 items).

Cartwright, D.E., and Young, C.M. Seiches and Tidal Ringing in the Sea near Shetland. Proceedings of the Royal Society of London, Series A, vol.338, p.111-128, 1974. (See annotation in Section I.)

Chesapeake Research Consortium, Inc., The. The Effects of Tropical Storm Agnes on the Chesapeake Bay Estuarine Sytems. The Johns Hopkins University Press, Baltimore and London, CRC Publication No.54, November 1976. (See annotation in Section VIII.)

Christodoulou, G.C., Leimkuhler, W.F., and Ippen, A.T. Mathematical Models of the Massachusetts Bay. Part III. A Mathematical Model for the Dispersion of Suspended Sediments in Coastal Waters. Ralph M. Parsons Laboratory for Water Resources and Hydrodynamics, Massachusetts Institute of Technology, Report No.179, January 1974. (See annotation in Section II.)

Conomos, T.J. Movement of Spilled Oil as Predicted by Estuarine Nontidal Drift. LIMNOLOGY AND OCEANOGRAPHY, vol.20, No.2, p.159-173, March 1975. (See annotation in Section IV.)

Conti, U. Water Pollution Monitoring. INDUSTRIAL PHOTOGRAPHY, vol.21, No.7, p.30-31, 49, July 1972.

A new system for measuring and assessing pollution in marine and estuarine environments is presented. The system should be more economical, more reliable, and easier to operate than a comparable pumping system. It consists of a towed vehicle about 4 ft long, capable of following a given vertical path and housing a number of sensors. The parameters measured are depth, DO, temperature, salinity, pH, chloride ion activity, sulfide ion activity, and ambient light. The system is powered by its own battery pack and does not require an electrical cable in the tow line. The problem of recording the 8 parameters was solved economically with a movie camera by translating the various parameters to voltages, which are displayed sequentially in alphanumeric form on a digital voltmeter. The monitoring system was tested at sea in Mexico and in San Francisco Bay and worked flawlessly. Very small changes in the measured parameters can be recorded.

Covill, R.W. The Quality of the Forth Estuary - Lothians Area. Paper presented at the 18th Meeting of the Institute of Environmental Sciences, New York, May 1-4, 1972, Proceedings, p.53-59. (See annotation in Section IV.)

Daiber, F.C. Flushing Pattern of Certain Tidal Streams in Delaware. Project Completion Report to Office of Water Resources Research, Department of the Interior, January 1972. (See annotation in Section I.)

Dalrymple, R.W., Knight, R.J., and Middleton, G.V. Intertidal Sand Bars in Cobequid Bay (Bay of Fundy). In: Estuarine Research, Volume II: Geology and Engineering, edited by L. Eugene Cronin, Academic Press, Inc., New York, 1975, p.293-307. (See annotation in Section II.)

Darmondy, R.G., Rabenhorst, M.C., and Foss, J.E. Bucket Auger Modification for Tidal Marsh Soil Sampling. Soil Science Society of America, Journal, vol.40, No.2, p.321-322, March-April 1976.

A simple modification of a standard bucket auger to permit sampling of both high and low n value marsh soils is described. A means of introducing air beneath the sample permitted retrieval of disturbed samples of marsh soils to a depth of 160 cm. Literature Cited (4 items).

DeAlteris, J.T., and Byrne, R.J. The Recent History of Wachapreague Inlet, Virginia. In: Estuarine Research, Volume II: Geology and Engineering, edited by L. Eugene Cronin, Academic Press, Inc., New York, 1975, p.167-181. (See annotation in Section II.)

DeGuida, R., Connor, J.J., and Pearce, B. Application of Estimation Theory to

Design of Sampling Programs for Verification of Coastal Dispersion Predictions Massachusetts Institute of Technology, Sea Grant Program, Report No MITSG 76-16, November 20, 1976 (See annotation in Section I.)

Diener, R.A. Cooperative Gulf of Mexico Estuarine Inventory and Study -- Texas Area Description. National Marine Fisheries Service, Galveston, Texas, Gulf Coast Fisheries Center, NOAA (National Oceanic and Atmospheric Administration) Technical Report NMFS CIRC-393, September 1975. (See annotation in Section VIII.)

Dorron, L.N., and Whitehurst, C.A. Channel Erosion in Southwestern Louisiana Canal. Journal of the Waterway, Port, Coastal and Ocean Division, Proceedings, ASCE, vol 104, No WW2, p 201-213, May 1978 (See annotation in Section II.)

Dooley, H.D. A Comparison of Drogue and Current Meter Measurements in Shallow Waters. Proceedings, Symposium, Physical Processes Responsible for Dispersal of Pollutants in the Sea, with Special Reference to the Near-Shore Zone, held in Arhus, Denmark, 4-7 July 1972, p.225-230 Copenhagen, Denmark, December 1974.

Since 1966 parachute drogues have been used by the Marine Laboratory as indicators of water movement, especially in the northern North Sea. Usually these have been used in conjunction with recording current meters and often the two methods gave differences in the estimate of current flow. An understanding of the reasons for these differences is important when considering the advection of, say, plankton populations or pollutants. The purpose of this paper is to discuss the various factors contributing to these differences. The current meters used were the type manufactured by Plessey and they were deployed suspended from a subsurface float. The parachute drogue configuration is shown. It consists of a seine net and equipped with a flashing light and radar reflector, a connecting line of 4 mm hydrographic wire and the drag device which is usually an 8.5 meter parachute. To aid recovery of the parachute a week link is incorporated as shown. (From paper.) References (4 items).

Dubach, H.W., Compiler. The North Carolina Coastal Zone and Its Environment; A Compilation of Resource Materials Covering the Coastal Plain, Estuaries, and Offshore Waters. Savannah River Laboratory, Aiken, South Carolina, DP-1423, November 1977. 2 vols. (See annotation in Section II.)

Dyer, K.R. The Measurement of Bed Shear Stresses and Bedload Transport Rates. Estuarine Processes, Volume II, Circulation, Sediments, and Transfer of Material in the Estuary, edited by Martin Wiley New York, Academic Press, 1977, p.[illegible]-[illegible]

Recent advances in the understanding of the characteristics of water flow near the sea bed and of the effect of the flow on sediment grains suggests that the bedload movement of sediment needs examination using more sophisticated techniques than those used in the past. Measurements of bedload transport rates have previously been carried out by a variety of sediment traps and samplers. These interfere with the flow, are selective in their retention and do not provide continuous samples. Measurements of the rate of advance of bedforms has been used, but this only gives a minimum transport rate. Techniques are required that will give quantitative estimates of the transport rate in a variety of time and space scales which can be related to the intermittancy in the bed shear stresses and the variations in bed form topography. Recent developments in electronics and instrumentation have suggested a number of techniques which are being applied to these problems. Those selected as being potentially most useful are a particle impact counter, the measurement of the self-generated noise of the sediment movement, and the development of a transponder simulating gravel particles. These techniques have limitations in their grain size reponse, but amongst their advantages is that of providing continuous measurements over a considerable period. References (57 items.)

Edwards, A., and Edelsten, D.J. Deep Water Renewal of Loch Etive: A Three Basin Scottish Fjord. ESTUARINE AND COASTAL MARINE SCIENCE, vol 5, No 5, p.575-595, September 1977. (See annotation in Section I.)

El-Sabh, M.I. Transport and Currents in the Gulf of St. Lawrence. Bedford Institute of Oceanography, Dartmouth, Nova Scotia, Canada, Report Series BI-R-75-9, July 1975. (See annotation in Section I.)

Everts, C.H., and Moore, H.E. Shoaling Rates and Related Data from Knik Arm near Anchorage, Alaska. U.S. Army Coastal

Engineering Research Center, Technical Paper No. 74-1, March 1974.

The Coastal Engineering Research Center (CERC) initiated the Alaska Harbor Sedimentation Program in 1966 to study sedimentation problems in small-craft harbors serving the Alaska fishing industry. The study is primarily limited to high tidal range (greater than 10 ft) estuaries where very high concentrations of suspended material (greater than 50 parts per million). The two study objectives are: (a) to develop and evaluate techniques to predict shoaling rates in a harbor prior to construction, and (b) to develop and evaluate methods for locating small-craft harbors where sedimentation would be minimized. Knik Arm is an estuary located at the northeastern end of Cook Inlet. Report presents data on shoaling rates and related parameters in Knik Arm near Anchorage, Alaska. A large sedimentation tank placed on a tidal flat at Knik Arm during the summers of 1971 and 1972 was used for the test. This report presents: (a) data of summertime shoaling rates in the tank and on the adjacent tidal flat, and (b) data on water and sediment characteristics, suspended sediment concentrations outside and inside the tank, and current velocities outside the tank. Additionally, some of the more evident relations of environmental data to shoaling rates are discussed, however, a more complete discussion of the mechanics of shoaling is planned for a future report. (Literature cited 10 items)

Ewart, T.E., and Bendtner, W.F. Techniques for Estuarine and Open Ocean Dye Dispersal Measurement. Proceedings, Symposium, Physical Processes Responsible for Dispersal of Pollutants in the Sea, with Special Reference to the Near-Shore Zone, held in Arhus, Denmark, 4-7 July 1972, p 201-232. Copenhagen, Denmark, December 1974.

Systems for in situ measurements of tracer dye dispersion rates have been developed for estuarine and open ocean dispersion studies. These systems are designed around an in situ fluorometer with a range of 10^{-6} to 10^{-12} gm cm^{-3} Rhodamine dye concentration. The estuarine system consists of a winch and digital data system capable of recording time, dye concentration, temperature, depth, bottom depth, ship's position, and event number every second. The open ocean system is capable of recording dye concentration, depth, temperature, and conductivity to depths of 5,500 meters using a free-swimming acoustically controlled vehicle. Experiments conducted in an estuarine system using dye simulation to study the excess temperature distribution resulting from a proposed nuclear reactor are discussed, as are preliminary results from an open ocean experiment conducted in March 1972 to measure deep ocean (1,000 meters) diffusion rates. References (21 items).

Ling, C.S., Parker, G., and Harrison, W. Hydrothermal Monitoring: Surry Nuclear Power Plant. Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, Copenhagen, Denmark, vol III, 1975, Chapter 143 (p.2431-2450).

A hydrothermal monitoring program has been designed and deployed to gather data on the temperature distribution in the tidal James River near the outfall of the Surry Nuclear Power Plant at Surry, Virginia, U.S.A. Monitoring to date has included two years of background data (1971 and 1972) taken prior to plant operation, and one year (1973) of data with the plant in operation. The results of the first year post operational monitoring effort has been compared with the pre-operation background data and with the thermal effects that were predicted from studies by Carpenter and Pritchard on the James River Hydraulic Model at Vicksburg, Mississippi. References (4 items).

Farmer, D.M., and Osborn, T.R. The Influence of Wind on the Surface Layer of a Stratified Inlet. Part I: Observations. JOURNAL OF PHYSICAL OCEANOGRAPHY, vol 6, No. 5, p 931-940, November 1976.

Observations are described in an experiment undertaken to determine the response of a stratified inlet to changing conditions of wind, tide and runoff. Time series of conductivity profiles taken in Alberni Inlet, British Columbia, show marked fluctuations in surface layer thickness that appear to be related to strong winds. The effect of an up-inlet wind is to produce a rapid thickening of the freshwater layer at the inlet head which may persist for several days. Strong winds were also associated with significant changes in the intensity of stratification. References (12 items).

Finley, R.J. Hydraulics and Dynamics of North Inlet, South Carolina, 1974-75. U.S. Army Corps of Engineers, General Investigation of Tidal Inlets, GITI Report 10, September 1976. (See annotation in Section I.)

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In: Estuarine Research, Volume II: Geology and Engineering, edited by L. Eugene Cronin, Academic Press, Inc., New York, 1975, p.277-291. (See annotation in Section II.)

Fisher, J.J. Criteria for Recognition of Estuarine Water Pollution by Aerial Remote Sensing. University of Rhode Island, Technical Completion Report, Project No.OWRR: A-031-RI, 1970.

Report describes a study of water quality in estuaries from multispectral photos. Five advantages of remote sensing for water pollution studies are listed. A multispectral camera system of four conventional 35-mm cameras fastened to a frame was developed for the research program. The characteristics and capabilities of the system are described. The study areas were along the west side of Narragansett Bay and at Point Judith Pond. The potential of four film types, conventional panchromatic, black and white infrared, color, and color infrared, was investigated. Results of using the photos for detection and evaluation of estuarine pollution sources are described. The technique to detect small and large pollution sources was important. The color and color infrared films gave the best results. A brief review of related studies is included. References Cited (12 items).

Forrester, W.D. Internal Tides in St. Lawrence Estuary. Bedford Institute of Oceanography, Collected Contributions, vol.7, No.410, p.74-85, 1974. (See annotation in Section I.)

Gallenne, B. Study of Fine Material in Suspension in the Estuary of the Loire and Its Dynamic Grading. ESTUARINE AND COASTAL MARINE SCIENCE, vol.2, p.261-272, July 1974. (See annotation in Section II.)

Gardner, G.B., and Smith, D. Turbulent Mixing in a Salt Wedge Estuary. Hydrodynamics of Estuaries and Fjords; Proceedings of the 9th Liege Colloquium on Ocean Hydrodynamics, 1977, p.79-106. University of Washington, Department of Oceanography, Contribution No.1003. (See annotation in Section III.)

Gerken, B. New Method for the Reduction of Soundings in the Tidal Area of the German Bight and in Tidal Flats, with the Outer Elbe Serving as Example. Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, Copenhagen, Denmark, vol.II, 1975, Chapter 58 (p.1009-1024).

This study aims at diminishing the gap between the tideland survey by leveling which can be done with high precision and the hydrographic survey so far often carried out unsatisfactorily. By further refinement of the technical position fixing and sounding devices better results are possible and desirable.

Godfrey, P.J., and Godfrey, M.M. Some Estuarine Consequences of Barrier Island Stabilization. In: Estuarine Research, Volume II: Geology and Engineering, edited by L. Eugene Cronin, Academic Press, Inc., New York, 1975, p.485-516. (See annotation in Section V.)

Goldsmith, V., Byrne, R.J., Sallenger, A.H., et al. The Influence of Waves on the Origin and Development of the Offset Coastal Inlets of the Southern Delmarva Peninsula, Virginia. In: Estuarine Research, Volume II: Geology and Engineering, edited by L. Eugene Cronin, Academic Press, Inc., New York, 1975, p.183-200. (See annotation in Section II.)

Gordon, R.B. Dispersion of Dredge Spoil Dumped in Near-Shore Waters. ESTUARINE AND COASTAL MARINE SCIENCE, vol.2, No.4, p.349-358, October 1974. (See annotation in Section V.)

Green, C.D. Sediments of the Tay Estuary. III. Sedimentological and Faunal Relationships on the Southern Shore at the Entrance to the Tay. The Royal Society of Edinburgh, Proceedings, Section B, vol.75, Parts 1/2, p.91-112, 1975. (See annotation in Section II.)

Green, C.D. A Study of Hydraulics and Bedforms at the Mouth of the Tay Estuary, Scotland. In: Estuarine Research, Volume II: Geology and Engineering, edited by L. Eugene Cronin, Academic Press, Inc., New York, 1975, p.323-344. (See annotation in Section II.)

Haas, L.W. The Effect of the Spring-Neap Tidal Cycle on the Vertical Salinity Structure of the James, York and Rappahannock Rivers, Virginia, U.S.A. ESTUARINE AND COASTAL MARINE SCIENCE, vol.5, No.4, p.485-496, July 1977. (See annotation in Section III.)

Halliwell, R., and O'Connor, B. Quantifying Spoil Disposal Practices.

Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, Copenhagen, Denmark, vol.III, 1975, Chapter 153 (p.2581-2600). (See annotation in Section II.)

Hansen, U.A. Wave Setup and Design Water Level. Journal of the Waterway, Port, Coastal and Ocean Division, Proceedings, ASCE, vol.104, No.WW2, p.227-240, May 1978.

During the winter of 1975-76 measurements were made by the Leichtweiss-Institut of the Technical University of Braunschweig at the west coast of the island of Sylt in the North Sea. The purpose of the field investigations was to determine the wave-induced setup in the surf zone and on the beach, defined as the height difference between the mean water level (MWL) and the still water level (SWL) and the influence of typical offshore parameters on this phenomenon. A new scheme was defined to determine the MWL as the mean value of the water surface variations measured at incremental time intervals over a certain time span. The maximum setup on the beach can reach values up to 30% of the incident significant wave height. The field investigations have shown that the rise of the mean water level due to wave setup is significant and should be taken in account in determining the design water level for coastal structures. References (22 items).

Harvey, J.G., and Vincent, C.E. Observations of Shear in Near-Bed Currents in the Southern North Sea. ESTUARINE AND COASTAL MARINE SCIENCE, vol.5, No.6, p.715-731, November 1977.

Measurements of current speed and direction have been made at four heights between 0.6 m and 10 m above the sea-bed at a location in the southern North Sea during a 14-day period. Tidal ellipses are presented for the currents at each height for both neap and spring tides. Speed profiles indicate that there is a logarithmic layer in the lowest 5 m of the water column; both the roughness lengths and the drag coefficients determined from these profiles decrease with increasing current speed. The current directions were found to exhibit positive veering, some 8° between 0.6 m and 3.0 above the bed, and a further 7° between 3.0 and 10 m above the bed. The maximum currents when the flow was directed between north and north-west (the ebb) were consistently stronger than those when it was directed between south and south-east (the flood) at each of the levels, and hence the residual currents were in the ebb direction. The residual currents were generally greater during spring tides than during neap tides, and also exhibited positive veering: the 14-day vector-mean current 0.6 m above the bed was directed some 25° to the left of that at 10 m. The residual flow can be considered part of a clockwise circulation around the Well Bank. References (30 items).

Hess, W.N., and Nelson, T.A. A Test Particle Dispersion Study in Massachusetts Bay. Seventh Annual Offshore Technology Conference, Houston, Texas, May 5-8, 1975; Proceedings, vol.I, Paper Number OTC 2160.

The development of predictive models to estimate in advance of dredging operations where the fines in a dredge plume will travel is an important goal. On June 11, 1973, 2700 kilograms (3 tons) of small ($0.5 < d < 50\mu$) particles were released into the water column in Massachusetts Bay and their movement tracked for 10 days. Also, oceanographic data were collected and analyzed and a dispersion model was formulated. Final data show the plume movement to be west toward Boston Harbor, eastward toward Stellwagen Bank and southward along the coast into Cape Cod where a counter-clockwise gyre is suggested. References (9 items).

Hine, A.C. Bedform Distribution and Migration Patterns on Tidal Deltas in the Chatham Harbor Estuary, Cape Cod, Massachusetts. In: Estuarine Research, Volume II: Geology and Engineering, edited by L. Eugene Cronin, Academic Press, Inc., New York, 1975, p.235-252. (See annotation in Section II.)

Horwood, J.W., and Bedwell, J.A. Results from a Hydrodynamical Mathematical Model of the Irish Sea. ECOLOGICAL MODELLING, vol.4, No.4, p.327-337, May 1978. (See annotation in Section VIII.)

Howarth, M.J. Current Surges in the St. Georges Channel. ESTUARINE AND COASTAL MARINE SCIENCE, vol.3, No.1, p.57-70, January 1975. (See annotation in Section VIII.)

Hubbard, D.K. Morphology and Hydrodynamics of the Merrimack River Ebb-Tidal Delta. In: Estuarine Research, Volume II: Geology and Engineering, edited by L. Eugene Cronin, Academic Press, Inc., New York, 1975, p.253-266. (See annotation in Section II.)

Hyer, P.V., and Ruzecki, E.P. Changes in Salinity Structure of the James, York and Rappahannock Estuaries Resulting from the Effects of Tropical Storm Agnes. In The Chesapeake Research Consortium, Inc., The Effects of Tropical Storm Agnes on the Chesapeake Bay Estuarine System, CRC Publication No.54, November 1976, p.66-80. (See annotation in Section III.)

International Symposium on Interrelationships of Estuarine and Continental Shelf Sedimentation, Bordeaux, France, Institut de Geologie du Bassin D'Aquitaine, 9-14 July 1973; Proceedings. Memoires de l'institut de Geologie du Bassin d'Aquitaine, No.7, 1974. (See annotation in Section II.)

Isfeld, E.O., Hay, D., and Rossouw, J. Field and Model Studies on a Siltation Problem in the Fraser River. Proceedings of the First Canadian Hydraulics Conference, held at the University of Alberta, May 10 & 11, 1973, p.44-63. (See annotation in Section VI.)

Jackson, H. W. Estuary Studies (161.3) (Training Manual). U.S. Environmental Protection Agency, Cincinnati, Ohio, September 1972. (See annotation in Section IV.)

John, E.J., and Cheryan, K.P. Geomorphological Studies of the Estuary of River Netravati near Mangalore. Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, Copenhagen, Denmark, vol.II, 1975, Chapter 76 (p.1304-1318). (See annotation in Section II.)

Johnson, F.A. A Reconnaissance of the Hydrology of the Edisto and Ashepoo Estuaries, South Carolina. South Carolina Water Resources Commission, Report No.6, 1977. (See annotation in Section III.)

Johnson, J.W. Bolinas Lagoon Inlet, California. U.S. Army Corps of Engineers, Coastal Engineering Research Center, Miscellaneous Paper No.3-74, May 1974; University of California, Hydraulic Engineering Laboratory, HEL 24-15, May 1974. (See annotation in Section II.)

Jordan, R.A. Observations on Dissolved Oxygen Conditions in Three Virginia Estuaries After Tropical Storm Agnes (Summer 1972). In The Chesapeake Research Consortium, Inc., The Effects of Tropical Storm Agnes on the Chesapeake Bay Estuarine System, CRC Publication No.54, November 1976, p.348-367. (See annotation in Section IV.)

Josefsson, B., and Nyquist, G. Fluorescence Tracing of the Flow and Disperson of Sulfite Wastes in a Fjord System. AMBIO, vol.5, No.4, p.183-187, 1976. (See annotation in Section IV.)

Judge, C.W. Use of the Radioisotopic Sand Tracer (RIST) System. Coastal Engineering Research Center, Technical Memorandum No.53, June 1975.

A synoptic sand tracing system has been developed capable of operating on the beach, in the surf zone, and offshore. This system has application in determining sediment movement along coastal areas. Some specific problems to which the system can be applied are: (a) mechanisms of sediment movement; (b) improving beach fill criteria; (c) relation of engineering structures to sediment transport; and (d) movement of disposal materials. Field tracing experiments were conducted which were designed toward the solution of particular problems. Some of the factors considered in planning the experiment include: Selection of the tracer, tidal state, predicted environmental conditions, availabl[illegible], and acceptance (or licensing) of the use of isotopes. After the isotope is injected, surveys are conducted for several days depending upon dispersion and isotope half-life. Results of recent tracer experiments demonstrate the utility of RIST in research and engineering studies. Literature Cited (26 items).

Kennedy, C. Cleaning Up a River. UNDERWATER NATURALIST, vol.7, No.4, p.4-12, November 1972. (See annotation in Section IV.)

Ketchum, B.H. Population, Resources, and Pollution, and Their Impact on the Hudson Estuary. Hudson River Colloquium. Annals of the New York Academy of Sciences, vol.250, p.144-156, May 24, 1974. (See annotation in Section IV.)

Kim, H.H., and Hickman, G.D. An Airborne Laser Fluorosensor for the Detection of Oil on Water. Second Joint Conference on Sensing of Environmental Pollutants, Washington, D.C., December 10-12, 1973, p.369-371.

Reports on the successful operation of an airborne laser fluorosensor system which is designed to detect and map surface

oil, either natural seepage or spills, in large bodies of water. The test flights were conducted in daylight. Preliminary results indicate that the sensitivity of the instrument exceeds that of conventional passive remote sensors which are available for the detection of an oil spill today. References (6 items).

Kjerfve, B. Tide and Fair-Weather Wind Effects in a Bar-Built Louisiana Estuary. In: Estuarine Research, Volume II: Geology and Engineering, edited by L. Eugene Cronin, Academic Press, Inc., New York, 1975, p.47-62. (See annotation in Section VIII.)

Klemas, V. Remote Sensing of Coastal Pollutants. Delaware University, College of Marine Studies, 1978. National Aeronautics and Space Administration, CR-157586.

Economic pressures to extract oil, dispose wastes, increase the harvest of food and recreational development in the coastal zone are creating the need to better understand the environmental changes taking place in many estuarine and coastal areas. The advantages and limitations of remote sensing techniques for collecting synoptic data over large coastal areas are reviewed with emphasis on low-cost, reliable methods. Specific applications include mapping the environmental impact of land development on coastal vegetation and ecology; charting current circulation and shoreline erosion; monitoring the dispersion of pollutants such as oil and sewage sludge; and determining the turbidity and eutrophication levels of water. The analysis of aircraft and satellite data with the aid of ground truth is illustrated, employing both inexpensive manual and automated computer techniques. Results indicate that a coordinated satellite-aircraft-boat approach can produce better results and/or cost less than the deployment of large numbers of boats or field teams without remote sensor support.

Klemas, V. Remote Sensing of Coastal Wetland Vegetation and Estuarine Water Properties. Estuarine Processes; Volume II, Circulation, Sediments, and Transfer of Material in the Estuary, edited by Martin Wiley. New York, Academic Press, 1977, p.381-403.

The advantages and limitations of remote sensing techniques for collecting synoptic data over large coastal and estuarine areas are reviewed with emphasis on the need for a proper balance between remotely sensed data and "ground truth." Specific applications include mapping wetland vegetation and coastal land use; monitoring natural and man-induced changes in the coastal zone; charting current circulation, including the movement and dispersion of known water pollutants; and determining the type and concentration of suspended matter in coastal waters. The photo-interpretation of aircraft and satellite imagery with the aid of "ground truth" is illustrated, employing both direct visual and automated computer techniques. For some applications, it is shown that an integrated boat-aircraft-satellite approach can produce better results or cost less, than the deployment of large numbers of boats or field teams without remote sensor support. References (53 items).

Klemas, V., and Polis, D.F. Remote Sensing of Estuarine Fronts and Their Effects on Pollutants. PHOTOGRAMMETRIC ENGINEERING AND REMOTE SENSING, vol.43, No.5, p.599-612, May 1977.

Estuarine fronts represent regions of extremely high gradient or discontinuity in various parameters of physical interest, the most important being the water velocity and density fields. Such fronts strongly influence pollutant dispersion by capturing oil slicks and other pollutants concentrated in surface films and drawing them down into the water column. Aircraft and boats were combined to study the behavior of different types of fronts in Delaware Bay and their effect on pollutants in order to provide a basis for improving an oil drift and spreading model. Imagery from the Landsat satellites provided the most effective means of determining the location and extent of frontal systems over all portions of the tidal cycle. This information is being used to modify the oil drift and spreading model. References (16 items).

Klemas, V., and Polis, D.F. A Study of Density Fronts and Their Effects on Coastal Pollutants. REMOTE SENSING OF ENVIRONMENT, vol.6, No.2, p.95-126, 1977.

Density fronts represent regions of extremely high gradient or discontinuity in various parameters of physical interest, the most important being the water velocity and density fields. Such fronts strongly influence pollutant dispersion, by capturing oil slicks and other pollutants concentrated in surface films and drawing them down into the water column. Satellites, aircraft, and boats were used to study the behavior of different types of fronts in Delaware Bay and their effect on pollutants in order to provide a

basis for improving an oil drift and spreading model. LANDSAT satellites provided the most effective means of determining the location and extent of frontal systems over all portions of the tidal cycle. Satellite observations of flood-associated fronts on the New Jersey side of the Bay and ebb-associated fronts on the Delaware side agreed with boat measurements and model predictions. References (17 items).

Klemas, V., Bartlett. D., Philpot, W., et al. Coastal and Estuarine Studies with ERTS-1 and Skylab. REMOTE SENSING OF ENVIRONMENT, vol.3, No.3, p.153-174, 1974.

Coastal vegetation, land use, current circulation, water turbidity, and ocean waste dispersion were studied by interpreting ERTS-1 and Skylab imagery with the help of ground truth collected during overpasses. Based on high-contrast targets such as piers and roads, the ERTS-1 multispectral scanner was found to have a resolution of 70-100 m, Skylab's S190A cameras about 20-40 m, and its S190B camera about 10-20 m. Important coastal land-use details can be more readily mapped using Skylab's imagery. On the other hand, the regular 18-day cycle of ERTS-1 allows observation of important manmade and natural changes and facilitates collection of ground truth. References (13 items).

Klemas, V., Davis, G., and Wang, H. A Cost-Effective Satellite-Aircraft-Drogue Approach for Studying Estuarine Circulation and Shelf Waste Dispersion. Ocean 75 Record: 1975 IEEE Conference on Engineering in the Ocean Environment, and Eleventh Annual Meeting of the Marine Technology Society, San Diego, California, September 22-25, 1975, p.751-760.

The mounting economic pressure to extract oil and other resources from the Continental Shelf and to continue using it for waste disposal is creating a need for cost-effective, synoptic means of determining currents in this area. An integrated satellite-aircraft-drogue approach has been developed which employs remotely tracked expendable drogues together with satellite observations of waste plumes and natural tracers, such as suspended sediment. Tests conducted on the Continental Shelf and in Delaware Bay indicate that the system provides a cost-effective means of monitoring current circulation and ocean waste dispersion even under severe environmental conditions. References (11 items).

Klemas, V., Davis, G., and Wang, H. Monitoring Estuarine Circulation and Ocean Waste Dispersion Using an Integrated Satellite-Aircraft-Drogue Approach. Proceedings of the International Conference on Environmental Sensing and Assessment, Las Vegas, Nevada, September 14-19, 1975, vol.I.

The mounting economic pressure to extract oil and other resources from the Continental Shelf and to continue using it for waste disposal is creating a need for cost-effective, synoptic means of determining currents in this area. An integrated satellite-aircraft-drogue approach has been developed which employs remotely tracked expendable drogues together with satellite and aircraft observations of waste plumes and tracers, such as dyes or suspended sediment. Tests conducted on the Continental Shelf and in Delaware Bay indicate that the system provides a cost-effective means of studying current circulation, oil slick movement and ocean waste dispersion even under severe environmental conditions. References (11 items).

Klemas, V., Davis, G., and Wang, H. Monitoring Estuarine Circulation and Ocean Waste Dispersion Using an Integrated Satellite-Aircraft-Drogue Approach. University of Delaware, College of Marine Studies, October 30, 1975.

The authors have identified the following significant results. An inexpensive, integrated drogue-aircraft-satellite approach was developed which is based on the Lagrangian technique and employs remotely tracked drogues and dyes together with satellite observation of natural tracers, such as suspended sediment. Results include current circulation studies in Delaware Bay in support of an oil slick movement model; investigations of the dispersion and movement of acid wastes dumped 40 miles off the Delaware coast; and coastal current circulation. In each case, the integrated drogue-aircraft-satellite approach compares favorably with other techniques on the basis of accuracy, cost effectiveness, and performance under severe weather conditions.

Klemas, V., Otley, M., Wethe, C., et al. Monitoring Coastal Water Properties and Current Circulation with Spacecraft. Second Joint Conference on Sensing of Environmental Pollutants, Washington, D.C., December 10-12, 1973, p.343-354.

Imagery and digital tapes from nine successful ERTS-1 passing over Delaware Bay

during different portions of the tidal cycle have been analyzed with special emphasis on turbidity, current circulation, waste disposal plumes and convergent boundaries between different water masses. ERTS-1 image radiance correlated well with Secchi depth and suspended sediment concentration. Circulation patterns observed by ERTS-1 during different parts of the tidal cycle, agreed well with predicted and measured currents throughout Delaware Bay. Convergent shear boundaries between different water masses were observed from ERTS-1. In several ERTS-1 frames, waste disposal plumes have been detected 36 miles off Delaware's Atlantic coast. The ERTS-1 results are being used to extend and verify hydrodynamic models of the bay, developed for predicting oil slick movement and estimating sediment transport. Bibilography (15 items).

Knebel, H.J., Conomos, T.J., and Commeau, J.A. Clay-Mineral Variability in the Suspended Sediments of the San Francisco Bay System, California. JOURNAL OF SEDIMENTARY PETROLOGY, vol.47, No.1, p.229-236, March 1977. (See annotation in Section II.)

Knoth, J.S., and Nummedal, D. Longshore Sediment Transport Using Fluorescent Tracer. Coastal Sediments '77, 5th Symposium of the Waterway, Port, Coastal and Ocean Division of ASCE, Charleston, South Carolina, November 2-4, 1977, p.383-398.

A project to determine the annual rate of longshore sediment transport, using fluorescent dyed sand as a tracer, was initiated as an aid in structural design prior to the U.S. Army Corps of Engineer's attempt to stabilize the eroding shoreline of North Bull Island, South Carolina. Data collection involved simultaneous acquisition of beach face sediment samples and surf zone wave process measurements. Tracer concentrations over time and space were determined from samples obtained in a grid pattern and along a transect downdrift of injection. Wave energy flux factors were calculated from bi-hourly measurements of wave energy and longshore current parameters. Theoretical estimates of longshore sediment transport rates based on these flux values and current velocities were calculated together with transport rates from the tracer study and compared to the standard rating curve for littoral transport. Results of the study tend to support the established relationship between longshore sediment transport and wave energy flux. References Cited (10 items).

Knowles, C.E. Flow Dynamics of the Neuse River Estuary, North Carolina, for the Period 7 August to 14 September 1973. University of North Carolina Sea Grant Program Publication UNC-SG-75-16, August 1975. (See annotation in Section I.)

Knowles, C.E., and Singer, J.J. Exchange Through a Barrier Island Inlet: Additional Evidence of Upwelling Off the Northeast Coast of North Carolina. JOURNAL OF PHYSICAL OCEANOGRAPHY, vol.7, No.1, p.146-152, January 1977. (See annotation in Section VIII.)

Koyama, H., and Ochiai, H. Studies on the Coastal Oceanography in the Vicinity of Fukuyama, Hiroshima, Pref. I. Distribution Patterns of Temperature, Chlorinity, pH and Inorganic Nutrient (Phosphate-P, Ammonia-N, Nitrite-N, Nitrate-N) Contents of Sea Water in Early February, 1968. Hiroshima Daigaku. Sui-Chikusangakubu, Fukuyama, Japan. Hiroshima Daigaku Sui-Chikusangakubu Kiyo, vol.11, No.1, p.65-77, July 1972. (In Japanese.) (See annotation in Section VIII.)

Kullenberg, G. Entrainment Velocity in Natural Stratified Vertical Shear Flow. ESTUARINE AND COASTAL MARINE SCIENCE, vol.5, No.3, p.329-338, May 1977. (See annotation in Section I.)

Kuo, A.Y., Ruzecki, E.P., and Fang, C.S. The Effects of the Agnes Flood on the Salinity Structure of the Lower Chesapeake Bay and Contiguous Waters. In The Chesapeake Research Consortium, Inc., The Effects of Tropical Storm Agnes on the Chesapeake Bay Estuarine System, CRC Publication No. 54, November 1976, p.81-103. (See annotation in Section III.)

Lambert, W.P., and Fruh, E.G. Methodology to Evaluate Alternative Coastal Zone Management Policies: Application in the Texas Coastal Zone. Special Report III: A Methodology for Investigating Fresh Water Inflow Requirements of a Texas Estuary; Volume I--Methodology. University of Texas at Austin, Center for Research in Water Resources, Environmental Health Engineering Research Laboratory, Technical Report EHE-76-01, CRWR-133, no date. (See annotation in Section I.)

Lambert, W.P., and Fruh, E.G. Methodology to Evaluate Alternative Coastal Zone Management Policies: Application in the Texas Coastal Zone. Special Report III: A Methodology for Investigating Fresh

Water Inflow Requirements of a Texas Estuary; Volume II--Appendices. University of Texas at Austin, Environmental Health Engineering Research Laboratory, Center for Research in Water Resources, no date. (See annotation in Section I.)

Leendertse, J.J., and Liu, S.-K. A Water-Quality Simulation Model for Well Mixed Estuaries and Coastal Seas: Volume VII, A Hindcast. Rand Institute, New York City, R-1774-NYC, July 1975. (See annotation in Section VI.)

Lewis, A.J., and MacDonald, H.C. Significance of Estuarine Meanders Identified from Radar Imagery of Eastern Panama and Northwestern Colombia. MODERN GEOLOGY, vol.1, No.3, p.187-196, 1970.

The use of radar imagery to examine estuarine meanders in Eastern Panama and Northwestern Colombia is described. The basic characteristics and modes of operation of radar imagery are covered. Radar imagery depicts drainage features very clearly, and is excellent for investigating the characteristics of estuarine meanders and other coastal drainage features. Estuarine meanders develop under certain environmental conditions and their presence can imply the nature of the coast in areas where they form. Estuarine meanders can also indicate the relative importance of fluvial and marine processes. Advantages of radar imagery in terrain studies are discussed. References (8 items).

Ludwick, J.C. Tidal Currents, Sediment Transport, and Sand Banks in Chesapeake Bay Entrance, Virginia. In: Estuarine Research, Volume II: Geology and Engineering, edited by L. Eugene Cronin, Academic Press, Inc., New York, 1975, p.365-380. (See annotation in Section II.)

Lutz, G.A., Hubbell, D.W., and Stevens, H.H., Jr. Discharge and Flow Distribution, Columbia River Estuary. U.S. Geological Survey, Professional Paper 433-P, 1975. (See annotation in Section VIII.)

Mauvais, J.-L., and Salomon, J.-C. Etude du frottement en Loire maritime (Study of Frictional Effects in the Loire Maritime Estuary). LA HOUILLE BLANCHE, vol.29, No.1/2, p.149-154, 1974. (In French.) (See annotation in Section I.)

May, E.B. Environmental Effects of Hydraulic Dredging in Estuaries. ALABAMA MARINE RESOURCES BULLETIN, No.9, p.1-85, April 1973. (See annotation in Section V.)

McDowell, D.M., and O'Connor, B.A. Hydraulic Behaviour of Estuaries. New York, John Wiley, 1977. (See annotation in Section I.)

Mehta, A.J., and Christensen, B.A. Incipient Sediment Motion in Entrances with Shell Beds. In: Rivers '76; Symposium on Inland Waterways for Navigation, Flood Control and Water Diversions; 3rd Annual Symposium of the Waterways, Harbors and Coastal Engineering Division of ASCE, Colorado State University, Fort Collins, August 10-12, 1976, vol.II, p.960-977, 1976. (See annotation in Section VI.)

Millard, J.P., Arvesen, J.C., Lewis, P.L., et al. Video Systems for Real-Time Oil-Spill Detection. Second Joint Conference on Sensing of Environmental Pollutants, Washington, D.C., December 10-12, 1973, p.355-361.

Three airborne television systems are being developed to evaluate techniques for oil-spill surveillance. These include a conventional TV camera, two cameras operating in a subtractive mode, and a field-sequential camera. False-color enhancement and wavelength and polarization filtering are also employed. The first of a series of flight tests indicates that an appropriately filtered conventional TV camera is a relatively inexpensive method of improving contrast between oil and water. False-color enhancement improves the contrast, but the problem caused by sun glint now limits the application to overcast days. Future effort will be aimed toward a one-camera system. Solving the sun-glint problem and developing the field-sequential camera into an operable system offers potential for color "flagging" oil on water. References (19 items).

Miller, G.H., and Berg, D.W. An ERTS-1 Study of Coastal Features on the North Carolina Coast. U.S. Army Corps of Engineers, Coastal Engineering Research Center, Miscellaneous Report No.76-2, January 1976.

Unenhanced imagery recorded by the multispectral scanner of the NASA Earth Resources Technology Satellite (ERTS-1) was analyzed to determine how satellite imagery may be applied to specific coastal engineering problems. The study area is a segment of the North Carolina coast comprising Wrightsville Beach, Masonboro Inlet, Masonboro Beach,

Carolina Beach Inlet, and Carolina Beach, which are areas of ongoing research by CERC. Analysis was supplemented by underflight imagery supplied by NASA and ground-truth data. Several significant coastal features are visible in the ERTS-1 imagery. Among those are plumes of suspended sediment emerging from inlets, changes in water coloration possibly due to effects of temperature change, inlet bars, and cape bars. In addition, morphological changes in selected coastal land features were determined by comparing ERTS-1 films obtained about 1 year apart. Literature Cited (14 items).

Mills, B.C. Coast Guard Airborne Remote Sensing System. Second Joint Conference on Sensing of Environmental Pollutants, Washington, D.C., December 10-12, 1973, p.363-367.

The Airborne Remote Sensing System is the Coast Guard's initial program to use state-of-the-art technology to assist us in our Congressionally mandated program of coastal zone pollution monitoring. The program has outfitted six U-16E aircraft with sensors capable of real time detection of pertroleum pollutants and a recording system furnishing a permanent record of any pollutants detected. The equipment was designed for daylight operation with one channel usable for night time operation. References (3 items).

Mumola, P.B. Multiwavelength Laser Induced Fluorescence of Algae in-vivo: A New Remote Sensing Technique. Second Joint Conference on Sensing of Environmental Pollutants, Washington, D.C., December 10-12, 1973, p.53-63.

In order to accurately determine the quantity of chlorophyll a in living algae by fluroescence spectrometry, either remotely or in the laboratory, the fluorescence excitation cross section must be known. Laboratory fluroescence studies of a number of different algae species representative of the various color groups were performed using phytoplankton supplied by the Virginia Institute of Marine Science. These measurements indicate distinct maximum spectral excitation regions which differ from one color group to another. Within each color group, however, the fluorescent properties were nearly identical, regardless of species. These two key features, namely: (1) the similarity of fluorescent properties within a color group, and (2) the distinct spectral differences between color groups, make possible the simulataneous determination of chlorophyll a content of an unknown mixture of phytoplankton and the distribution of chlorophyll a among the various color groups. The multiple wavelength LIDAR equations are developed and chlorophyll a concentrations are calculated using matrix inversion techniques. The design and application of a flight-qualified multiwavelength laser flurosensor for performing remote measurements from an airborne platform are described. The application of this technique to wide area surveys of water resources is discussed. References (17 items).

Munday, J.C., Jr., Byrne, R.J., Welch, C.S., et al. Applications of Remote Sensing to Estuarine Problems. Annual Report No. 3. Virginia Institute of Marine Science, December 1975.

A variety of siting problems for the estuaries of the lower Chesapeake Bay have been solved with cost beneficial remote sensing techniques. Principal techniques used were repetitive 1:30,000 color photography of dye-emitting buoys to map circulation patterns, and investigation of water color boundaries via color and color infrared imagery to scales of 1:120,000. Problems solved included sewage outfall siting, shoreline preservation and enhancement, oil pollution risk assessment, and protection of shellfish beds from dredge operations. References (15 items).

Munday, J.C., Jr., Gordon, H.H., Welch, C.S., et al. Applications of Remote Sensing to Estuarine Management. Annual Report No.4. Virginia Institute of Marine Science, July 1976.

Projects for sewage outfall siting for pollution control in the lower Chesapeake Bay wetlands are reported. A dye-buoy/photogrammetry and remote sensing technique was employed to gather circulation data used in outfall siting. This technique is greatly favored over alternate methods because it is inexpensive, produces results quickly, and reveals Lagrangian current paths which are preferred in making siting decisions. Wetlands data were obtained by interpretation of color and color infrared photographic imagery from several altitiudes. Historical sequences of photographs are shown that were used to document wetlands changes. Sequential infrared photography of inlet basins was employed to determine tidal prisms, which were input to mathematical models to be used by state agencies in pollution control. A direct and crucial link between remote sensing and management decisions was demonstrated in the various projects. (Author.)

Murray, S., Conlon, D., Siripong, A., et al. Circulation and Salinity Distribution in the Rio Guayas Estuary, Ecuador. In: Estuarine Research, Volume II: Geology and Engineering, edited by L. Eugene Cronin, Academic Press, Inc., New York, 1975, p.345-363. (See annotation in Section III.)

Nasner, H. Prediction of the Height of Tidal Dunes in Estuaries. Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, Copenhagen, Denmark, vol.II, 1975, Chapter 60 (p.1036-1050). (See annotation in Section II.)

National Research Council, Geophysics of Estuaries Panel. Estuaries, Geophysics, and the Environment. National Academy of Sciences, Washington, D.C., 1977. (See annotation in Section IV.)

Nece, R.E., and Knoll, C.R. Flushing and Water Quality Characteristics of Small-Boat Marinas. Charles W. Harris Hydraulics Laboratory, University of Washington, Seattle, Technical Report No.40, June 1974. (See annotation in Section IV.)

Nece, R.E., Welch, E.B., and Reed, J.R. Flushing Criteria for Salt Water Marinas. Charles W. Harris Hydraulics Laboratory, University of Washington, Seattle, Technical Report No.42, June 1975. (See annotation in Section IV.)

Neumaier, G., and Silvestro, F. Measurement of Pollution Using Multiband and Color Photography. In New Horizons in Color Aerial Photography; Seminar Proceedings, jointly presented by The American Society of Photogrammetry and The Society of Photographic Scientists and Engineers, June 9-11, 1969, New York City, p.47-58.

Since 1964 we have been performing research to assess the application of remote sensing to water quality management. Special emphasis has been placed upon developing techniques and procedures based on the spectral characteristics of various pollutant discharges. The purpose of this paper is to describe the approach we have taken and to show how remote sensing can be used as a tool for detecting and measuring water pollution both qualitatively and quantitatively. In a program sponsored by the New York State Conservation Department, laboratory experiments were performed to determine the spectral characteristics of effluents from a paper industry, an oil industry, and a sewage plant. These data, along with theoretical studies, were used to extract the desired information from multiband aerial photographs taken over these discharges. The techniques employed allow estimation of pollution concentration in a number of cases. (References (6 items).

Ohlmeyer, F., and Berndt, D. Field and Model Data of Spreading in Estuaries. Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, Copenhagen, Denmark, vol.III, 1975, Chapter 137 (p.2357-2367). (See annotation in Section VI.)

Oil and Estuary Pollution Control: A Quick Look at Some Developments. WATER & WASTE TREATMENT, vol.18, No.7, p.24-28. July 1975. (See annotation in Section IV.)

Olufeagba, B.J., Flake, R.H., and Armstrong, N.E. A Boundary Value Approach for Estuarine Water Quality Modelling with Results for Jamaica Bay, New York. ECOLOGICAL MODELLING, vol.1, No.1, p.3-30, May 1975. (See annotation in Section VI.)

Orme, A.R. Estuarine Sedimentation Along the Natal Coast, South Africa. University of California, Department of Geography, Los Angeles, Technical Report No.5, August 1974. (See annotation in Section II.)

Oviatt, C.A., and Nixon, S.W. Sediment Resuspension and Deposition in Narragansett Bay. ESTUARINE AND COASTAL MARINE SCIENCE, vol.3, No.2, p.201-217, April 1975. (See annotation in Section II.)

Ozsoy, E. Flow and Mass Transport in the Vicinity of Tidal Inlets. Coastal and Oceanographic Engineering Laboratory, University of Florida, Gainesville, UFL/COEL/TR-036, 1977. (See annotation in Section I.)

Parker, R.R., and Sibert, J. Effect of Pulpmill Effluent on Dissolved Oxygen in a Stratified Estuary--I. Empirical Observations. WATER RESEARCH, vol.7, No.4, p.503-514, April 1973. (See annotation in Section IV.)

Parsons, T.V., and Fisher, R.A. Experience with Radioisotope Tracing in Local Tidal Waters. WATER POLLUTION CONTROL, vol.76, No.1, p.59-64, 1977.

Radioactive isotopes have been used as tracers by Harwell over the last 25 years. Their use has given civil engineers, water authorities and many branches of industry the ability to label and trace water, sewage and various industrial effluents including chemicals, china clay waste and dredged silt or sand. During the last 2 years, the Hampshire River Authority, the South Hampshire Main Drainage Board and latterly, the Southern Water Authority, have been concerned with the dilution and dispersion of sewage effluent in the Solent, Portsmouth Harbour and Lanstone Harbour and this paper relates to those investigations using radioactive tracers.

Pasenau, H. Giant and Mega Ripples in the German Bight and Studies of Their Migration in a Testing Area (Lister Tief). Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, Copenhagen, Denmark, vol.II, 1975, Chapter 59 (p.1025-1035). (See annotation in Section II.)

Patel, B., Mulay, C.D., and Ganguly, A.K. Radioecology of Bombay Harbour -- A Tidal Estuary. ESTUARINE AND COASTAL MARINE SCIENCE, vol.3, No.1, p.13-42, January 1975. (See annotation in Section VIII.)

Paulson, R.W. Estuarine Studies. Earth Resources Aircraft Program Status Review, Volume III - Hydrology, Oceanography, and Sensor Studies, Section 24; Presented at the NASA Manned Spacecraft Center, Houston, Texas, September 16 to 18, 1968.

The objective of the U.S. Geological Survey estuarine remote-sensing program is to determine the feasibility of using remote sensors for studying estuaries from aircraft or spacecraft platforms. The particular objectives of the Delaware Estuary Program are to determine whether variations in water quality, which are known to exist in this highly polluted water body, can be detected remotely and to devise methods for using remote-sensing data to solve estuarine problems.

Pequegnat, W.E. Meiobenthos Ecosystems as Indicators of the Effects of Dredging. In: Estuarine Research, Volume II: Geology and Engineering, edited by L. Eugene Cronin, Academic Press, Inc., New York, 1975, p.573-583. (See annotation in Section IV.)

Peterson, D.H., Conomos, T.J., Broenkow, W.W., et al. Location of the Non-Tidal Current Null Zone in Northern San Francisco Bay. ESTUARINE AND COASTAL MARINE SCIENCE, vol.3, No.1, p.1-11, January 1975. (See annotation in Section III.)

Physical and Biological Aspects of the Tay Estuary; A Symposium held in the Rooms of the Royal Society of Edinburgh, Edinburgh (Scotland), 5 December 1973. The Royal Society of Edinburgh, Proceedings, Section B, vol.75, Parts 1/2, 1975. (See annotation in Section VIII.)

Pickral, J.C., and Odum, W.E. Benthic Detritus in a Saltmarsh Tidal Creek. Estuarine Processes; Volume II, Circulation, Sediments, and Transfer of Material in the Estuary, edited by Martin Wiley. New York, Academic Press, 1977, p.280-292.

A new benthic sampling device was developed to permit convenient, quantitative collection of organic detritus from submerged sediment surfaces. The apparatus was used to investigate the spatial and temporal distribution of benthic detritus in a tidal, saltmarsh creek adjacent to the York River, Virginia. Diurnal, monthly, and seasonal samples were collected and partitioned into detrital size fractions. Each size fraction was analyzed to determine the percentage of root, stem, and leaf tissue contributed by the dominant marsh plants. The standing stock and composition of detritus varied in a characteristic manner across the width and along the lenth of the tidal creek. Temporal differences were also evident, especially those associated with periodic storms. The data indicate apparent relationships between the morphology of the creek, current velocities, substrate texture, and the distribution and composition of the benthic detritus. References (30 items).

Pijanowski, B.S. Comparative Evaluation of In-Situ Water Quality Sensors. Second Joint Conference on Sensing of Environmental Pollutants, Washington, D.C., December 10-12, 1973, p.95-107.

Five commercially available in-situ water quality monitoring systems measuring conductivity, temperature, dissolved oxygen and pH were evaluated for performance under both laboratory and field conditions. The instruments included in the evaluation are: Hydrolab Corp. Surveyor; Leeds & Northrup Corp. Water Qaulity System; Martek Corp. Mark 3; Ocean Data Equipment Corp. Model WQMS-101A; and Whitney/Montedoro Corp. Mark II. Each is described briefly and the various sensor types are discussed. Testing methodology

is described and a number of user considerations are discussed including initial checkout and calibration. Detailed test results are given for all sensors on each system concerning effects of primary power variation, time response, relative accuracy, repeatability, stability, pressure effects, and intersystem interference. Field test results in a salt water environment are presented. Overall systems specifications and results are summarized comparatively by charts. Also discussed is the author's idea of the optimum characteristics for an ideal system based upon testing experience. References (2 items).

Pollock, T.J., and Wallis, I.G. Dispersion and Tidal Flushing in Hann's Inlet. Geophysical Fluid Dynamics Laboratory, Monash University, Clayton, Victoria, Australia, G.F.D.L. Report No.45, Issued November 1971, Re-issued August 1974. (See annotation in Section VIII.)

Pollock, T.J., Hinwood, J.B., O'Brien, W.T., et al. Calibration Data for a Numerical Hydrodynamic Model. Fifth Australasian Conference on Hydraulics and Fluid Mechanics, University of Canterbury, Christchurch, New Zealand, 9-13 December 1974; Conference Proceedings, vol.II, p.276-283.

Paper describes the field data collection program designed to supply calibration data for a numerical hydrodynamic model of Westernport Bay. The calibration procedure adopted is described and some initial results are presented. References (2 items).

Pollution Criteria for Estuaries; Proceedings of the Conference held at the University of Southampton, July 1973; edited by P.R. Helliwell and J. Bossanyi. John Wiley & Sons, New York, 1975. (See annotation in Section IV.)

Pontin, R.A., and Reid, J.A. The Freshwater Input to the Tay Estuary. The Royal Society of Edinburgh, Proceedings, Section B, vol.75, Parts 1/2, p.1-9, 1975. (See annotation in Section VIII.)

Porter, E. Pollution in Four Industrialized Estuaries. HMSO, London, 1973. 98p. (See annotation in Section IV.)

Posmentier, E.S., and Rachlin, J.W. Distribution of Salinity and Temperature in the Hudson Estuary. JOURNAL OF PHYSICAL OCEANOGRAPHY, vol.6, No.5, p.775-777, September 1976. (See annotation in Section I.)

Prater, B.E. The Metal Content and Dispersion Characteristics of Steelworks' Effluents Discharging to the Tees Estuary. WATER POLLUTION CONTROL, vol.74, No.1, p.63-78, 1975. (See annotation in Section IV.)

Pugh, D.T., and Waller, W.R. Sea-Level Measurements in the Wash Bay. Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, Copenhagen, Denmark, vol.III, 1975, Chapter 149 (p.2519-2538).

A report (Binnie and Partners, 1965) on the water resources of the Great Ouse Basin put forward proposals for storage in the Wash of fresh water from the four rivers draining into the bay. The scheme suggested was to take the form of a barrage, enclosing about a third of the area of the bay, behind which fresh water would be stored in raised impoundments. Four years later (Binnie and Partners, 1970) this proposal was superseded by a scheme for storage in bunded reservoirs built on the foreshore at the head of the bay. The current Wash Feasibility Study (commenced in 1971) is expected to highlight the most suitable scheme of this sort following a program which includes field data collection, hydraulic and mathematical model testing and site investigations. The scheme as currently envisaged would take the form of bunded reservoirs built (largely from dredged sea bed material) on the forshore close to the outfall of the river Great Ouse and connected by tunnel to intakes on that river, and later on the river Nene. To meet increasing demand further impoundments could be built along the foreshore to store water drawn from the other rivers draining into the Wash. Figure 1 shows a possible reservoir scheme which is among those being considered. Continuous sea level observations have been made at 4 points in the Wash bay using automatic level recorders. The purpose was to provide information on tides and surges in connection with the feasibility study. References (9 items).

Pullen, E.J., and Trent, L. Hydrographic Observations from a Natural Marsh and a Marsh Altered by Dredging, Bulkheading, and Filling in West Bay, Texas. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Data Report 97, October 1974. (See annotation in Section VIII.)

Ree, W.J. van de, and Schaap, H.Y. Measured Contributions of the Terms of the Vertically Integrated Hydrodynamic Equations. Symposium on Modeling Techniques, 2nd Annual Symposium of the Waterways, Harbors and Coastal Engineering Division of ASCE, San Francisco, California, September 3-5, 1975, vol.II, p.1237-1248. (See annotation in Section VI.)

Remote Sensing of the Environment; Part 2: Dynamics, A Bibliography with Abstracts. National Technical Information Service, NTIS/PS-78/0564, June 1978.

Remote sensing methods as they are applied to ocean currents, wind sediment transport, ocean waves, sea states, and air water interactions are described. The various techniques of measurement using radiometers, lasers, radar, and microwave and infrared equipment are described.

Roberts, W.P., and Pierce, J.W. Deposition in Upper Patuxent Estuary, Maryland, 1968-1969. ESTUARINE AND COASTAL MARINE SCIENCE, vol.4, No.3, p.267-280, May 1976. (See annotation in Section II.)

Robinson, A.H.W. Cyclical Changes in *Shoreline Development* at the Entrance to Teignmouth Harbour, Devon, England. In: Nearshore Sediment Dynamics and Sedimentation; An Interdisciplinary Review, edited by J. Hails and A. Carr; John Wiley & Sons, London, 1975, Chapter 8 (p.181-200). (See annotation in Section II.)

Rudder, C.L., and Reinheimer, C.J. Detection of Water Pollution Sources with Aerial Imaging Sensors. Second Joint Conference on Sensing of Environmental Pollution, Washington, D.C., December 10-12, 1973, p.65-71.

This paper addresses the very important requirement for imagery interpretation keys used by interpreters to extract information from data collected with imaging sensors. Examples of aerial imagery are discussed to emphasize the value of such keys.

Ruzecki, E.P., and Ayers, R., Suspended Sediments near Pier 12, Norfolk Navy Base, on 26 June and 15 September 1973. Virginia Institute of Marine Science, Data Report No.11, October 1974. (See annotation in Section II.)

Ruzecki, E.P., Hargis, W.J., Jr., and Fang, C.S. Effects of Flooding on a Coastal Plain Estuary. Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, Copenhagen, Denmark, vol.III, 1975, Chapter 144 (p.2451-2470). (See annotation in Section VIII.)

Sager, G. Spatial Interpolation of Tidal Streams (Flachenhafte Interpolation bei Gezeitenstromen). British Library Lending Division, RTS 10485, January 1977. (See annotation in Section VI.)

Schaffranek, R.W., and Baltzer, R.A. Compiling Bathymetry for Flow Simulation Models. Symposium on Modeling Techniques, 2nd Annual Symposium of the Waterways, Harbors and Coastal Engineering Division of ASCE, San Francisco, California, vol.II, September 3-5, 1975, p.1329-1346.

A highly modular, automated bathymetric data collection and processing system has been developed by the Geological Survey in support of its modeling effort. This system permits rapid, economical collection and processing of the detailed bathymetric data required to properly schematize the bottom configuration of river, estuary, lake, reservoir, and (or) coastal embayment models. The system is composed of the electronic equipment used to acquire the data and a closely integrated comprehensive set of computer programs to process the data. Hardware components include a precision radio ranging unit, a depth sounder, a precision clock, a digital plotter, a digital tape recorder, and a mini-computer that controls and monitors the operation of the individual components. The computer software system is designed to process, edit, verify, triangulate, collate and otherwise transform the bathymetric data into numerical arrays or graphical products in support of the modeling effort. References (5 items).

Schroeder, W.W., and Morton, R.R. ERTS Data Collection Platform System for Monitoring the *Surface Hydrography of Mobile* Bay, Alabama. MARINE TECHNOLOGY SOCIETY JOURNAL, vol.10, No.8, p.21-25, October-November 1976.

An anchored buoy system and shore receiving station that are part of an Earth Resources Technology Satellite (ERTS--now called Landsat) Data Collection Platform (DCP) Project in Mobile Bay, Alabama, are described. The first phase of the project focused on evaluating the feasibility

of utilizing DCP's in shallow coastal waters. Thirty days of surface hydrographic results are presented. A comparison of data received by the shore station to data received via satellite relay indicated that the former provided a more complete coverage of hydrographic fluctuation. References (4 items).

Schubel, J.R. Effects of Agnes on the Suspended Sediment of the Chesapeake Bay and Contiguous Shelf Waters. In The Chesapeake Research Consortium, Inc., The Effects of Tropical Storm Agnes on the Chesapeake Bay Estuarine System, CRC Publication No.54, November 1976, p.179-200.

The flooding rivers discharged massive amounts of suspended sediment into the Chesapeake Bay estuarine system. In the 10-day period, 21-30 June 1972, the Susquehanna discharged more than 31×10^6 metric tons of suspended sediment into the Bay. Its annual input during most years is only $0.5\text{-}1.0 \times 10^6$ metric tons. Concentrations of suspended sediment throughout much of the Chesapeake Bay estuarine system were higher than any previously reported. During the period of peak riverflow the upper Bay was characterized by a marked longitudinal gradient of suspended sediment. On 26 June 1972, two days after the Susquehanna crested, the concentration of suspended sediment in the surface waters dropped from more than 700 mg/ℓ at the head of the Bay (Turkey Point) to 400 mg/ℓ at Tolchester, and to 175 mg/ℓ at the Annapolis Bay Bridge. Concentrations of suspended sediment in the upper Bay remained anomalously high for about a month after Agnes. In the middle and lower reaches of the Bay concentrations of suspend d sediment were 2-3 times higher than "normal," and the outflow from the Bay could be traced as a band of low salinity, turbid water that turned south and flowed along the Virginia and Carolina coasts. Literature Cited (11 items).

Schubel, J.R., Carter, H.H., and Cronin, W.B. Effects of Agnes on the Distribution of Salinity Along the Main Axis of the Bay and in Contiguous Shelf Waters. In The Chesapeake Research Consortium, Inc., The Effects of Tropical Storm Agnes on the Chesapeake Bay Estuarine System, CRC Publication No.54, November 1976, p.33-65. (See annotation in Section III.)

Sedgwick, R., and Arthur, D.R. A Natural Pollution Experiment: The Effects of a Sewage Strike on the Fauna of the Thames Estuary. ENVIRONMENTAL POLLUTION, vol.11, No.2, p.137-160, September 1976. (See annotation in Section IV.)

Seklon, K.S., and Binder, R.C. Ultrasonic Techniques to Measure Water Pollutants. Second Joint Conference on Sensing of Environmental Pollutants, Washington, D.C., December 10-12, 1973, p.177-184.

Ultrasonic velocity and absorption of sound energy were measured to determine the degree of pollution in fresh and sea water. An improved sing-around technique was employed to measure sonic velocity in the media. The accuracy of the test equipment was checked by measuring sonic velocity in distilled water. The data were compared with that of National Bureau of Standards. The mean deviation between the author's data and National Bureau of Standards data was less than 0.2 percent. Sonic velocity and percent attenuation were measured in a number of test samples collected from various locations between Los Angeles Harbor and San Diego Beach. The results are presented General References (18 items).

Sherk, J.A., Jr., O'Connor, J.M., and Neumann, D.A. Effects of Suspended Solids on Selected Estuarine Plankton U.S. Army Coastal Engineering Research Center, Miscellaneous Report No.76-1, January 1976. (See annotation in Section II.)

Shideler, G.L. Physical Parameter Distribution Patterns in Bottom Sediments of the Lower Chesapeake Bay Estuary, Virginia. JOURNAL OF SEDIMENTARY PETROLOGY, vol.45, No.3, p.728-737, September 1975. (See annotation in Section II.)

Shultz, D.J. Stable Carbon Isotope Variations in Organic and Inorganic Carbon Reservoirs in the Fenholloway River Estuary and the Mississippi River Estuary. Ph.D. Dissertation, Florida State University, March 1974. (See annotation in Section VIII.)

Sindern, J., and Schröder, G.E. Aerial Photographic Waterline Survey of an Estuary. Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, Copenhagen, Denmark, vol.III, 1975, Chapter 148 (p.2504-2518).

The project of a barrage across an estuary in Northern Germany was accompanied by a program to monitor the hydrologic and morphologic situation. This became necessary in order to avoid dangers resulting from the sensitivity of the

shallow ribbon area to human interference. Various methods to record the morphology were tested. The aerial photographic waterline survey proved superior as it supplies a complete and economic record and allows accurate analysis of the topography. The principle consists in taking aerial photographs at short time intervals between low water and high water, each photo showing a different waterline. The scale chosen was 1:18000, corresponding to a flight altitude of 2700 meters. Rectification of the distorted photos requires reference markers to be distributed over the survey area which measures about 140 km². By using simultaneous tide gauge records, contour lines can be constructed from the photographed waterlines. This morphologic record is supplemented by submarine survey of the estuary. It is expected that details of sediment transport and of tidal prism changes may be revealed. Predicted and actual effects of the barrage will be compared, which might lead to a better understanding of such coasts.

Slotta, L.S., Sollitt, C.K., Bella, D.A., et al. Effects of Hopper Dredging and in Channel Spoiling (October 4, 1972) in Coos Bay, Oregon. Oregon State University, Corvallis, July 1973. 147p. (See annotation in Section V.)

Smith, N.P. Long-Period, Estuarine-Shelf Exchanges in Response to Meteorological Forcing. Hydrodynamics of Estuaries and Fjords; Proceedings of the 9th Liege Colloquium on Ocean Hydrodynamics, 1977, p.147-159. (See annotation in Section I.)

Smyth, J.C., and Curtis, D.J. Intertidal Organisms of an Industrialized Estuary. MARINE POLLUTION BULLETIN, vol.5, No.12, p.188-191, December 1974. (See annotation in Section IV.)

Snowden, J.O., and Otvos, E.G. Chemical Quality of Surface and Sediment Pore Water in Louisiana and Mississippi Estuaries. Louisiana Water Resources Research Institute, Completion Report B-009-LA, October 1973. (See annotation in Section VIII.)

Sonu, C.J., and Wright, L.D. Mass Transport and Dispersion Off a Tidal Inlet. Seventh Offshore Technology Conference, Houston, Texas, May 5-8, 1975; Proceedings, vol.III, Paper No. OTC 2383. (See annotation in Section I.)

Stevenson, J.C., Heinle, D.R., Flemer, D.A., et al. Nutrient Exchanges Between Brackish Water and Marshes and the Estuary. Estuarine Processes; Volume II, Circulation, Sediments, and Transfer of Material in the Estuary, edited by Martin Wiley. New York, Academic Press, 1977, p.219-240. (See annotation in Section I.)

Stoertz, G.E., Hemphill, W.R., and Markle, D.A. Airborne Fluorometer Applicable to Marine and Estuarine Studies. Marine Technology Society Journal, vol.3, No.6, p.11-26, November 1969.

An experimental Fraunhofer line discriminator detected solar-stimulated yellow fluorescence (5890 A) emitted by Rhodamine WT dye in aqueous solutions. Concentration of 1 part per billion was detected in tap water 1.2 meter deep. In extremely turbid San Francisco Bay, dye was monitored in concentrations of less than 5 parts per billion from helicopter and ship. Applications include studies of current dynamics and dispersion. Potential applications of the technique could include sensing oil spills, fish oils, lignin sulfonates, other fluorescent pollutants, and chlorophyll fluorescence. References (10 items)

Stone, J.H. Louisiana Superport Studies, Report No.2: Preliminary Assessment of the Environmental Impact of a Superport on the Southeastern Coastal Area of Louisiana. Louisiana State University, Department of Marine Sciences, Center for Wetland Resources, No.LSU-SG-72-07, Report 2, 1972.

The objectives were (1) to conduct an overall environmental evaluation of a superport operation at two hypothetical locations on the continental shelf off the southeast coast of Louisiana, (2) to establish within the limits of available data the existing environmental conditions at and around the proposed sites, and (3) to predict and/or document (a) the effects of an oil spill at or near the proposed sites and (b) the effects of operations. Oil-drift projections indicate that the site more distant from shore would have less effect because a potential spill there would probably not reach the estuarine areas. Oil-drift projections of hypothetical oil spills are based on a hydrodynamical numerical model using wind conditions, local tides, and bathymetry. At the closer offshore site oil spills moved either northwest toward Timbalier Bay or northeast toward Barataria Bay. Oil spills at the farther

offshore site did not impinge on the sh relines nor into the estuaries. Potential adverse effects resulting from an oil spill would be most severe in the estuaries. Oil could damage or kill extensive areas of marsh grass, thereby reducing or eliminating the most important food source for the major consumers, which are fishery species. Damage to the Gulf shoreline would probably be minimal unless the oil concentrated in the littoral currents, which are also used as a migratory aid. References (115 items)

Sullivan, K.H. The Effect of Tidal Currents on Planned Effluent Discharge in Puget Sound. Ocean 75 Record: 1975 IEEE Conference on Engineering in the Ocean Environment, and Eleventh Annual Meeting of the Marine Technology Society, San Diego, California, September 22-25, 1975, p.940-943. (See annotation in Section IV.)

Swartz, R.C. Techniques for Sampling and Analyzing the Marine Macrobenthos. U.S. Environmental Protection Agency, Corvallis Environmental Research Laboratory, EPA-600/3-78-030, March 1978.

The report presents guidelines for the quantitative assessment of the effects of marine pollution on benthic community structures and pollution dynamics. The sampling design addresses the number and location of the stations, survey frequency, sampling gear, replication of samples, screening and preservation of biological samples, and the collection of abiotic data. Recommendations are given for the sorting, identification, enumeration, and weighing of benthic specimens. The section on data analysis suggests indices for detecting changes in species composition, density, dispersion, richness, dominance, and spatial-temporal faunal homogeneity. References (18 items).

Symposium on Direct Tracer Measurement of the Reaeration Capacity of Streams and Estuaries, July 7-8, 1970. Proceedings . . . Georgia Institute of Technology, Atlanta; Ernest C. Tsiviglou, Mark A. McClanahan, and Walter M. Sanders, III. Environmental Protection Agency, Water Pollution Control Research Report, Project 16050 FOR, January 1972.

A symposium on direct measurement of the reaeration capacity of streams and estuaries was conducted in July 1970 at the Georgia Inst. of Technology. Papers presented provide an outline of the fundamentals of gas transfer in turbulent systems, the theory and application of radiotracers for measuring gas transfer in natural waters, and the associated field and laboratory procedures. A new theory regarding the relationship between the reaeration capacity and hydraulic properties of natural streams is presented, together with early supporting observed results (numerous graphs, refs, and tables).

Taylor, D. Natural Distribution of Trace Metals in Sediments from a Coastal Environment, Ior Bay, England. ESTUARINE AND COASTAL MARINE SCIENCE, vol.2, No.4, p.417-424, October 1974. (See annotation in Section VIII.)

Taylor, R.B., and Dean, R.G. Exchange Characteristics of Tidal Inlets. Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, Copenhagen, Denmark, vol.III, 1975, Chapter 142 (p.2268-2289). (See annotation in Section I.)

Teleki, P.G., and DeMaster, Z. Sediment Transport Studies for Port Engineering, Corinto, Nicaragua. Proceedings, XVIth Congress of the International Association for Hydraulic Research, São Paulo, Brazil, July 27 to August 1, 1975, vol.I, Paper A5. (See annotation in Section II.)

Texas Water Development Board. Techniques for Evaluating the Effects of Water Resources Development on Estuarine Environments. Texas Department of Water Resources, LP-75, 1978. (See annotation in Section VI.)

Thorn, M.F.C. Deep Tidal Flow over a Fine Sand Bed. Proceedings, XVIth Congress of the International Association for Hydraulic Research, São Paulo, Brazil, July 27 to August 1, 1975, vol.1, Paper A27. (See annotation in Section II.)

Thorn, M.F.C. Monitoring Silt Movement in Suspension in a Tidal Estuary. Proceedings, XVIth Congress of the International Association for Hydraulic Research, São Paulo, Brazil, July 27 to August 1, 1975, vol.3, Paper C21. (See annotation in Section II.)

Trites, R.W. Capacity of an Estuary to Accept Pollutants. In: Effects of Elemental Phosphorus on Marine Life. Fisheries Research Board of Canada, Research and Development, Halifax, N.S.

Scotia, Circular No.2, p.57-69, November 1972. (See annotation in Section IV.)

Trites, R.W., and Walton, A. A Canadian coastal Sea - The Gulf of St. Lawrence. Bedford Institute of Oceanography, Dartmouth, Nova Scotia, Canada, Report Series BI-R-75-15, October 1975. (See annotation in Section VIII.)

U.S. Army Engineer District, Baltimore. Impact of Tropical Storm Agnes on Chesapeake Bay. March 1975. 2 vols. (See annotation in Section VIII.)

U.S. Army Engineer District, San Francisco. Dredge Disposal Study, San Francisco Bay and Estuary. Main Report and Appendices A through M. 1974-1977. (See annotation in Section IV.)

U.S. Army Engineer Waterways Experiment Station. Chesapeake Bay Radioactive Tracer Study, by A.R. Tool. Miscellaneous Paper H-76-1, January 1976.

A radioactive tracer study was conducted in the Chesapeake Bay near the Pooles Island Deep disposal area to obtain qualitative information concerning movement of dredged material placed in the area. Approximately 15 curies of gold^{198} was mixed with a sediment sample and placed on the bottom of the Bay. Daily tracings of the labeled sediment revealed movement along a narrow band in the general direction of the tidal currents. Movement in the direction of flood flow was determined to be much greater than that in the direction of ebb flow. References (15 items).

U.S. Army Engineer Waterway Experiment Station. Masonboro Inlet, North Carolina: Movable-Bed Hydraulic Model Study, Effects of Temperature and Experimental Procedures, by R.A. Sager and N.W. Hollyfield. Miscellaneous Paper H-75-10, December 1975. (See annotation in Section VI.)

U.S. Army Engineer Waterways Experiment Station. Mathematical Model of Estuarial Sediment Transport, by R. Ariathurai, R.C. MacArthur, and R.B. Krone. Technical Report D-77-12, October 1977. (See annotation in Section VI.)

U.S. Geological Survey. Digital Flow Model of the Chowan River Estuary, North Carolina, by C.C. Daniel. Water Resources Investigations 77-63, August 1977. (See annotation in Section VI.)

Van Haverbeke, L., and Brown, C.W. Water Pollution Studies Using Raman Spectroscopy. University of Rhode Island, Department of Chemistry, Kingston, 1976. (See annotation in Section IV.)

Vincent, C.E., and Smith, D.J. Measurements of Waves in Southampton Water and Their Variation with the Velocity of the Tidal Current. ESTUARINE AND COASTAL MARINE SCIENCE, vol.4, No.6, p.641-652, November 1976. (See annotation in Section I.)

Visher, G.S., and Howard, J.D. Dynamic Relationship Between Hydraulics and Sedimentation in the Altamaha Estuary. JOURNAL OF SEDIMENTARY PETROLOGY, vol.44, No.2, p.502-521, June 1974. (See annotation in Section II.)

Wang, Y.-H, Smutz, M., Ruth, B.E., et al. Satellite Applications to a Coastal Inlet Study, Clearwater Beach, Florida. University of Florida, Gainesville, Coastal and Oceanographic Engineering Laboratory, UFL/COEL-77/026, December 1977.

Two sets of Landsat magnetic tapes were obtained and displayed on the screen of an IMAGE 100 computer. Spectral analysis was performed to produce various signatures, their extent and location. Subsequent ground truth observations and measurements were gathered by means of hydrographic surveys and low-altitude aerial photography for interpretation and calibration of the Landsat data. Finally, a coastal engineering assessment based on the Landsat data was made. Recommendations to the City of Clearwater regarding the navigational channel alignment and dredging practice are presented in the light of the inlet stability. References (4 items).

Ward, P.R.B. Measurements of Estuary Dispersion Coefficients. Journal of the Environmental Engineering Division, Proc. ASCE, vol.102, No.EE4, p.855-860, August 1976. (See annotation in Section I.)

Waters, C.B. Experiences in the Operation of Waverider Buoys. Proceedings, XVIth Congress of the International Association for Hydraulic Research, Sao Paulo, Brazil, July 27 to August 1, 1975, vol.1, Paper A48.

A long-term wave climate study in the Thames estuary, using Waverider buoys, was started in December 1972. Simultaneous wave recordings have been obtained from six sites. The report gives details of experiences gathered during two years of operations. Problems have been encountered with moorings, radio reception, corrosion and accelerometer stability, and methods adopted to overcome them are described. Details are given of buoy calibrations, battery life and techniques used to improve data retrieval from chart recordings. A description is given of a purpose built magnetic tape data acquisition system which has been in use since November 1973. Results obtained so far are summarized. References (5 items).

Weisberg, R.H. A Note on Estuarine Mean Flow Estimation. JOURNAL OF MARINE RESEARCH, vol.34, No.3, p.387-394, August 1976.

The sampling interval required for estuarine mean flow estimation is examined. Examples drawn from the literature show that nontidal estuarine flow is highly variable and that under common everyday conditions this variance is predominantly wind-induced. Thus, record lengths sufficiently longer than the time scale of locally energetic wind fluctuations are required. A nondimensional parameter expressing the number of tidal cycles which must be averaged over to attain a given error tolerance is offered. Since this parameter may be estimated prior to a measurement program it may serve as an aid in estuarine experimental design. References (13 items).

Weisberg, R.H., and Sturges, W. Velocity Observations in the West Passage of Narragansett Bay: A Partially Mixed Estuary. JOURNAL OF PHYSICAL OCEANOGRAPHY, vol.6, No.4, p.345-354, May 1976. (See annotation in Section VIII.)

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Dye-flushing surveys have been carried out at the following harbors: (1) Beach Gardens Resort Harbour, (2) Powell River South Harbour, and (3) Westview North Harbour. The rate of flushing of the dye, which represents suspended or dissolved pollutants, was substantial at each harbor. The most important factor with respect to flushing appears to be the tidal stream excursions at the harbor entrance. A lower flushing rate was found at Westview North Harbour than at the other harbors surveyed due to more profound reversals in the tidal stream outside the harbor entrance which returned dye to the harbor on flood tides. The flushing of surface debris and contaminants appears to be most greatly affected by the type and alignment of the mooring floats. List of References (10 items).

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The goal of this study was to develop a predictive model to estimate, in advance of dredging operations, where the fines of a dredge plume would travel. On June 11, 1973, 2700 kg (3 tons) of small particles were released into the water column in Massachusetts Bay. Their movement was tracked for 7 days. Also, oceanographic data were collected and analyzed and a dispersion model was formulated. Final data show the plume movement to be westward toward Boston Harbor, eastward toward Stellwagen Bank and southward along the coast into Cape Cod Bay where a counterclockwise gyre is suggested. References (10 items).

Wood, F.J. The Strategic Role of Perigean Spring Tides in Nautical History and North American Coastal Flooding, 1935-1976. Washington, U.S. National Oceanic and Atmospheric Administration, 1978. (See annotation in Section I.)

Wright, F.F. Estuarine Oceanography. McGraw-Hill Book Company, New York, St. Louis, etc., 1974. American Geological Institute, Council on Education in the Geological Sciences, CEGS Programs Publication Number 18. 76p.

Edited by J.E. Lewis and R. Pestrong, McGraw-Hill Concepts in Introductory Geology. Publication is structured as a laboratory supplement for undergraduate college classes but should be useful at all levels. It consists of two distinct parts: a text covering general concepts and stressing the small-scale technology necessary to study small natural bodies of water, and a rather detailed exercise describing an (somewhat) ideal estuary. Describes general characteristics of the estuarine zone and the physical processes, both natural and artificial, that are found in estuaries, and some basic techniques necessary for the scientific study of estuaries. In the second part, a study program for a typical estuary is described, especially in the context of potential pollution problems.

Wright, L.D., and Sonu, C.J. Processes of Sediment Transport and Tidal Delta Development in a Stratified Tidal Inlet. In: Estuarine Research, Volume II: Geology and Engineering, edited by L. Eugene Cronin, Academic Press, Inc., New York, 1975, p.63-76. (See annotation in Section II.)

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Yost, E., and Wenderoth, S. Coastal and Estuarine Applications of Multispectral Photography. 4th Annual Earth Resources Program Review, Presented at the Manned Apacecraft Center, Houston, Texas, January 17 to 21, 1972, vol.IV, Section 110-1 - 110-17.

An evaluation of multispectral photographic techniques for optical penetration of water in the northeastern United States and the Gulf of Mexico coastal waters is presented. The spectral band (493 to 543 nanom), when exposed to place the water mass at about unit density on the photgraphic emulsion, was found to provide the best water penetration, independent of altitude or time of day, as long as solar glitter from the surface of the water is avoided. An isoluminous color technique was perfected, which eliminates the dimension of brightness from a multispectral color presentation. References (4 items).

Zwarts, C.M.G. A Transmission Line Wave Height Transducer. Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, Copenhagen, Denmark, vol.I, 1975, Chapter 9 (p.193-211).

A simple but accurate wave transducer has been developed for the measurement of waves and tidal levels on inland and coastal waters. It consists of a tunnel diode oscillator, using a transmission line to sense the water-level. The output voltage consists of a square wave, with a period linearly proportional to the water-level. In addition an analog output signal is provided. The quasi-static accuracy of the instrument is equal to or less than 0.2%. References (8 items).

SECTION VIII. BASIC PHYSICAL DATA

Tide tables, datum planes, tidal current charts, and the results, tabulation, and discussion of basic physical data obtained from field surveys, investigations, and data collection programs. Physical features of ports, harbors, estuaries, etc., when related to tidal hydraulic problems.

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Alexander, V., Burrell, D.C., Chang, J., et al. Environmental Studies of an Arctic Estuarine System - Final Report. Institute of Marine Science, University of Alaska, Fairbanks, EPA-660/3-75-026, June 1975.

The Colville River estuarine system was studied over a period of four years. Physical, chemical, geomorphological, and biological features were included. North slope river deltas differ significantly from those elsewhere, due to climatological extremes and a long, cold, dark winter with continuous ice-cover and continuous daylight during the summer with melting ice or open water. Basic information has been obtained on the winds, waves, and currents. Predominant current directions are from the west, with wind drift currents with a periodicity of 4 to 5 days. Beach sediments are characterized as poorly sorted gravelly sandy sediment in a relatively low energy environment. The ice-free biological regime is strongly influenced by the river input of low salinity water containing relatively high concentrations of nitrogen nutrients. An annual primary production in the estuary is estimated at 10-15 g-C/m^2. Crustaceans, molluscs, and polychaetes characterize the macrofauna at depths exceeding 2 m, with but few species responsible for most of the biomass. Interesting features of the chemical regime are connected with the isolation of hypersaline water in the shallow estuarine and river system. Fresh water systems were included in the study. References at end of each chapter.

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Anwar, H.O. Turbulent Dispersion and Meandering of a Surface Plume. Proceedings, XVIth Congress of the International Association for Hydraulic Research, São Paulo, Brazil, July 27 to August 1, 1975, vol.1, Paper A46. (See annotation in Section I.)

April, G.C., Hill, D.O., and Liu, H.-A. Hydrodynamic and Material Transport Model for Mobile Bay, Alabama. Symposium on Modeling Techniques, 2nd Annual Symposium of the Waterways, Harbors, and Coastal Engineering Division of ASCE, San Francisco, California, September 3-5, 1975, vol.I, p.764-782. (See annotation in Section VI.)

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Preliminary water qulity studies conducted in the general vicinity of Suisun Bay indicate that suspended organic and inorganic particulate materials become entrapped in this portion of the Sacramento-San Joaquin estuary. The area of entrapment occurs in the fresh-saltwater mixing zone where surface electrical conductivities range from approximately 1,000 to 4,000 µmho/cm. Suspended materials transported through this zone apparently flocculate and/or settle to the bottom where there is a net upstream flow. The materials accumulate in this zone at concentrations greater than adjacent upstream or downstream areas. Possible implications of the entrapment zone to the Delta environment are suggested.

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Barwis, J.H. Catalog of Tidal Inlet Aerial Photography. U.S. Army Corps of Engineers, General Investigation of Tidal Inlets, GITI Report 75-2, June 1975.

A program of research conducted jointly by U.S. Army Coastal Engineering Research Center, Fort Belvoir, Virginia, and U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Data on approximately 6000 aerial photographic coverages of tidal inlets are presented in tabular form, along with information on how any given photograph may be obtained. The compilation covers inlets along the Atlantic, Gulf, and Pacific coasts of the contiguous U.S. coastline from 1938 to 1974, and includes the following information: 1. Inlet name. 2. Geographic coordinates. 3. National Ocean Survey navigation chart covering inlet. 4. Georef grid square. 5. Month and year of photography. 6. Federal, state, or commercial agency holding *film*. 7. *Project number*. 8. *Pertinent* exposure numbers. 9. Scale. 10. Film type. Information is also given on sources of additional photography, and on obtaining photography of beach areas between any two inlets. An index, by Corps of Engineers District, is given.

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The major sources and sinks of suspended particulate carbon are identified for northern Chesapeake Bay, Maryland, USA. The area of the bay under consideration was divided into two sections. The northernmost section (upper bay), from the head of the bay to the vicinity of Baltimore, was characterized by a high input of particulate carbon from upland drainage. The section from Baltimore to the mouth of the Potomac River (middle bay) was dominated by an internal supply of particulate carbon from primary production. The northernmost section was characterized by major particulate carbon losses to the bottom and to benthic respiration, with slightly less than half (43%) of the particulate carbon respired in the water column or converted to dissolved organic matter. In contrast, respiration in the water column or conversion to dissolved organic matter was responsible for the loss of about 65% of the particulate carbon in the middle section of the bay, while losses to the bottom and to benthic respiration totaled only 12%. Even though the supply of particulate carbon to the upper bay was about 1.5 times the supply to the middle bay, the loss of carbon due to biological activity (biological efficiency) in each area was similar, and amounted to about 70% of the supply of particulate carbon. Literature Cited (14 items).

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Predictions of sediment transport rates in coastal waters often display large

errors. The source of the error is in part the result of insufficient attention to the character of the shear stress field in unsteady-nonuniform flows. A review of available laboratory and field data is used to show that shear stress magnitude and distribution will vary in response to the sense and amplitude of the horizontal pressure gradient. The response appears sufficient to alter both bed and suspended load transport. The consistency of the data indicates that present predictive techniques, based on uniform flow data, should be modified so as to permit inclusion of probable pressure gradient effects. References (18 items).

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Byrne, R.J., DeAlteris, J.T., and Bullock, P.A. Channel Stability in Tidal Inlets: A Case Study. Proceedings of the Fourteenth Coastal Engineering Conference, June 24-28, 1974, Copenhagen, Denmark, vol.II, 1975, Chapter 92 (p.1585-1604). (See annotation in Section II.)

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The specific goals of the research described herein were three-fold. First of all, the author provides information regarding the actual distribution of excess heat from the Morgantown Generating Station to investigators working on other aspects of the joint study; secondly, to provide implicit quantification of the physical processes of advection and turbulent diffusion for tuning and/or constructing numerical models of this portion of the Potomac Estuary, and thirdly to conduct both a preoperational and postoperational study for purposes of prediction of the probable distribution of excess heat and subsequent verification (postoperational). The first two objectives were achieved. References (6 items).

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The hydrological effects of the storm are investigated, including the effects of flood waters on the salinity distribution in Chesapeake Bay, its major tributaries and contiguous continental shelf. The geological effects and water quality effects are also studied. The biological effects on shellfishes, fishes, blue crabs, aquatic plants, jellyfish, and plankton are described. The economic impact of the flood on the shellfish and finfish industries, as well as on recreational industries, is reported. Public health impacts such as shellfish closings, water contact closings, shellfish contamination, waterborne pathogens, and miscellaneous hazards are also discussed. Literature Cited.

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Dellow, D.J., and Sutherland, A.J. Velocity Distribution Measurements in Tidal Streams. Fifth Australasian Conference on Hydraulics and Fluid Mechanics, University of Canterbury, Christchurch, New Zealand, 9-13 December 1974; Conference Proceedings, vol.II, p.133-140. (See annotation in Section I.)

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The hydrography of the Broadkill River, a narrow shallow estuary in southeastern Delaware, was studied from July 1966, through February 1971. Measurements of current velocity, tide stage, salinity, water temperature, dissolved oxygen, pH, and trubidity were made at several stations along the course of the estuary. The Broadkill River has characteristics of both a partially mixed and a well-mixed estuary. During normal runoff the system discharges 1.3×10^5 m^3 of freshwater seaward per tidal cycle. The flushing time of the entire system increases from 10.3 tidal cycles during high runoff to 24.2 tidal cycles during low runoff. For purposes of analysis, the Broadkill River was divided into three sections: the lower and upper estuaries, and the tidal river. The lower estuary, the most seaward 25% of the system, is sectionally homogeneous during 90% of each tidal cycle. Homogeneity is maintained by strong tidal currents. Vertical salinity and water temperature stratification occur only during a short interval of simultaneous two-dimensional current flow at the beginning of each flooding period. Salinity, water temperature, dissolved oxygen, pH, and turbidity generally reflect conditions in the adjoining lower Delaware Bay. Net non-tidal current flow is seaward at all depths. The flushing time of the lower estuary is relatively constant and increases from 0.6 to 0.9 tidal cycle with decreasing freshwater runoff. The upper estuary, the central 35% of the system, has the most distinct longitudinal and vertical salinity gradients. Tidal currents are slower than those in the lower estuary. Net non-tidal flow may be either two-directional or seaward at all depths. Dissolved oxygen and pH generally decrease and turbidity increases with distance upstream through this section. The flushing time of the upper estuary increases from 3.2 to 4.6 tidal cycles with decreasing freshwater runoff. The tidal river, the farthest upstream 40% of the system, is rarely invaded by saline water from the upper estuary. This section is polluted through the discharge of organic wastes into the river at a point 0.5 km downstream from the river's source, Wagamon's Pond at Milton, Delaware. Downstream from the source of pollution, anoxic conditions are present from spring through autumn and are relieved only during the coldest months of the winter. The lowest pH readings and greatest turbidities also occur in this section of the tidal river. The discharge from Wagamon's Pond dominates the tidal river upstream from the source of pollution. In this section dissolved oxygen rarely decreases below 8 mg/liter. The pH readings are generally higher than those in the anoxic section, and the water in this section is the least turbid of any water in the Broadkill River. The slowest tidal currents occur in the tidal river, and net non-tidal flow is generally seaward at all depths. The flushing time of the tidal river increases from 6.7 to 18.7 tidal cycles with decreasing freshwater runoff. Literature Cited (13 items).

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Seven Texas estuarine areas are described in terms of their dimensions; major vegetation types; geology and geological history; drainage basins and stream discharge records; hydrological, biological, and benthic properties; populations and economic development; pollution; and navigation projects. These areas include the Sabine Lake Galveston Bay, Matagorda Bay-Brazos River Delta, San Antonio Bay, Copano-Aransas Bay, Corpus Christi Bay, and the Laguna Madre. A list of

pertinent literature is also presented. Literature Cited (51 items).

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An experiment involving the intensive measurement of salinity and tidal currents was undertaken in the Potomac estuary during September 1974. An initial analysis of the data has suggested that there was a current reversal associated with a reversal of the horizontal salinity gradients near the mouth of the estuary. The dynamics were further complicated by oscillations of the tidally averaged free surface which fluctuated by more than 50 cm in the days following the downstream wind stress. It seems likely that the variations in elevation were caused by the cross stream component of the wind stress which, although unlikely to have a direct effect on the Potomac, would probably have a significant effect on the circulation in the Chesapeake Bay. References (8 items).

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Low level liquid radioactive waste from nuclear facilities at Bhabha Atomic Research Centre, Bombay, is released into Bombay Harbour after monitoring and dilution. The interactions of γ-emitting fission product nuclides, especially ^{137}Cs, with sedimentary particles and biota were studied during 1968-71. Cesium-137 is first scavenged by the sedimentary particles, followed by ^{144}Ce and ^{106}Ru. Zirconiumniobium-95, though present in the effluent, was not sorbed. Cesium-137 was distributed throughout the harbor, whereas Ce and Ru deposition were limited to a few stations off Trombay coast. The ark-shell bivalve, Anadara granosa, showed specific accumulation of Cs, Ce, and Ru nuclides but not of 95 Zr-Nb, although it was present in the effluent. A. granosa was used as an indicator to detect contamination due to Ce and Ru radionuclides. Lamellibranchs and crustaceans were the most effective integrators of ^{137}Cs, with concentration factors for the nuclide from 10^2 to 10^5. The radiation dose through the contaminated environment to the benthic communities was far below the limits required to produce any detectable radiation damage. The radiation dose to fisherman,

internally through the consumption of contaminated marine products and externally through fishing over the contaminated bed, was well below the permissible dose limit. References (61 items).

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A field study was completed which utilized stable carbon isotope measurements in an attempt to understand the pathway of terrestrial organic and inorganic carbon in estuaries. It was found that in the Fenholloway estuary terrestrial particulate organic matter mixed ideally with marine particulate organic matter. This mixture evidently is deposited in the sediments because there is a gradient in the sediment from terrestrial δC^{13} values at the mouth of the Fenholloway River to δC^{13} values typical of marine sediments 5.6 km away from the mouth. Calculations showed that the amount of terrestrial particulate organic matter brought to the Gulf by the Fenholloway River is greater than the amount of terrestrial organic carbon calculated to be present in the sediment. Evidence was presented which indicated some terrestrial dissolved organic carbon is oxidized to CO_2 by bacteria in the Fenholloway estuary. In addition, evidence from studies of IOC and δC^{13}_{IOC} data showed that the oxidation of terrestrial dissolved organic matter takes place immediately after the anoxic river water starts to mix with the oxygenated Gulf water. For the much larger and more complex Mississippi estuary, terrestrial particulate matter appeared to be settling out to the sediments. Calculations showed that the amount of terrestrial particulate matter brought to the estuary by the river was approximately equal to the amount of terrestrial organic matter calculated to be in the estuarine sediments. The distribution of terrestrial particulate matter in the surface waters of the estuary was shown to be a function of the complex mixing taking place. Terrestrial dissolved organic carbon did not seem to be controlled by mixing processes alone. Inorganic carbon did seem to be controlled by ideal mixing in the Mississippi estuary. It was demonstrated through calculations that the dissolved inorganic carbon in the rivers was not in equilibrium with atmospheric carbon dioxide. These calculations indicate there is more dissolved inorganic carbon than should be present at equilibrium. The excess dissolved inorganic carbon could be accounted for by oxidation of organic matter and dissolution of calcium carbonate. Similar calculations for marine waters showed that surface waters were close to equilibrium with atmospheric carbon dioxide. Subsurface IOC samples in the Mississippi offshore area were found to be isotopically more negative than surface samples. Calculations showed that this change could be accounted for by dissolution of calcium carbonate and oxidation of marine organic carbon to carbon dioxide. Bibiography (46 items).

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Narragansett Bay is a weekly stratified estuary comprised of three connecting passages of varying depths. The vertical distribution of horizontal velocity was observed in the West Passage using moored current meters. The instantaneous motion was characterized by semi-diurnal tidal currents of amplitude 25-60 cm s^{-1}.

These currents exhibited a phase advance with depth (total water depth = 12.8 m) ranging with lunar phase from 0-3 h. The net current time series obtained by filtering out motions at tidal and higher frequencies were found to be an order of magnitude less than the instantaneous motion and well correlated to the prevailing 2-10 m s^{-1} winds. For periodicities of 2-3 days, the coherence between the longitudinal components of wind and net near surface current was as high as 0.8 with the current lagging the wind by about 3 h. The mean near surface speed, obtained by averaging over one month, was 1.2 ± 1.6 cm s^{-1}. The large error bounds were a result of the large variability of the net current time series (and not a result of inadequate sampling). A measure of this variability due to day-to-day changes in weather is given by the root mean square deviation of the net current time series or 2.6 cm s^{-1}. The net transport of water through the West Passage was observed to be seaward or landward over the entire water column for several days duration, with typical wind induced transport fluctuations of ±500 m^3 s^{-1}. Hence, a net communication of water exists between the East and West Passages with water flowing either way in response to the wind. Wind is concluded to be the dominant mechanism driving the net circulation in the West Passage of Narragansett Bay. This is in contrast with the classical views of gravitationally convected net estuarine circulation. References (15 items).

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In accordance with letter from DAEN-RDC, DAEN-ASI dated 22 July 1977, Subject: Facsimile Catalog Cards for Laboratory Technical Publications, a facsimile catalog card in Library of Congress MARC format is reproduced below.

Committee on Tidal Hydraulics
Bibliography on tidal hydraulics; Report No.2, Supplement No.8; supplementary material compiled from June 1974 to June 1980; tidal flows in rivers and harbors. Vicksburg, Miss. : U. S. Waterways Experiment Station, 1980.
293 p. ; 27 cm. (Bibliography on Tidal Hydraulics, Report No.2, Supplement No.8)

1. Bibliographies. 2. Harbors. 3. Rivers. 4. Tidal hydraulics. I. United States. Army. Corps of Engineers. Committee on Tidal Hydraulics. II. Series: United States. Waterways Experiment Station, Vicksburg, Miss. Bibliography on Tidal Hydraulics, Report No.2, Supplement No.8.
GC303 C6 No.2 Suppl.

REPORTS OF COMMITTEE ON TIDAL HYDRAULICS

Report No.	Title	Date
1	Evaluation of Present State of Knowledge of Factors Affecting Tidal Hydraulics and Related Phenomena	Feb 1950
2	Bibliography on Tidal Hydraulics	Feb 1954
	Supplement No. 1, Material Compiled Through May 1955	Jun 1955
	Supplement No. 2, Material Compiled from May 1955 to May 1957	May 1957
	Supplement No. 3, Material Compiled from May 1957 to May 1959	May 1959
	Supplement No. 4, Material Compiled from May 1959 to May 1965	May 1965
	Supplement No. 5, Material Compiled from May 1965 to May 1968	Aug 1968
	Supplement No. 6, Material Compiled from May 1968 to May 1971	Jul 1971
	Supplement No. 7, Material Compiled from May 1971 to May 1974	Jun 1975
3	Evaluation of Present State of Knowledge of Factors Affecting Tidal Hydraulics and Related Phenomena (revised edition of Report No. 1)	May 1965

Technical Bulletin No.	Title	Date
1	Sediment Discharge Measurements in Tidal Waterways	May 1954
2	Fresh Water-Salt Water Density Currents, A Major Cause of Siltation in Estuaries	Apr 1957
3	Tidal Flow in Entrances	Jan 1960
4	Soil as a Factor in Shoaling Processes, A Literature Review	Jun 1960
5	One-Dimensional Analysis of Salinity Intrusion in Estuaries	Jun 1961
6	Typical Major Tidal Hydraulic Problems in United States and Research Sponsored by the Corps of Engineers Committee on Tidal Hydraulics	Jun 1963
7	A Study of Rheologic Properties of Estuarial Sediments	Sep 1963
8	Channel Depth as a Factor in Estuarine Sedimentation	Mar 1965
9	A Comparison of an Estuary Tide Calculation by Hydraulic Model and Computer	Jun 1965
10	Significance of Clay Minerals in Shoaling Problems	Sep 1966
11	Extracts from The Manual of Tides	Sep 1966
12	Unpublished Consultation Reports on Corps of Engineers Tidal Projects	Dec 1966
13	Two-Dimensional Aspects of Salinity Intrusion in Estuaries: Analysis of Salinity and Velocity Distributions	Jun 1967
14	Tidal Flow in Entrances; Water-Level Fluctuations of Basins in Communication with Seas	Jul 1967
15	Special Analytic Study of Methods for Estuarine Water Resources Planning	Mar 1969
16	The Computation of Tides and Currents in Estuaries and Canal	Sep 1969
	Appendix A: A User's Manual	Jun 1973
17	Estuarine Navigation Projects	Jan 1971
18	History of the Corps of Engineers Committee on Tidal Hydraulics	Jun 1972
19	A Field Study of Flocculation as a Factor in Estuarial Shoaling Processes	Jun 1972
20	Unsteady Salinity Intrusion in Estuaries	
	Part I: One-Dimensional, Transient Salinity Intrusion with Varying Freshwater Inflow	Jul 1974
	Part II: Two-Dimensional Analysis of Time-Averaged Salinity and Velocity Profiles	Jul 1974
21	Evaluation of Numerical Storm Surge Models	Dec 1980


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